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The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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The Defence Proposals—I

By the time these lines appear in print the country will have read the forthcoming debate in the House of Commons on the proposed defence measures, outlined in the White Paper. We are not concerned with the political exigencies that have made them necessary, nor with arguments as to whether they go too far, or not far enough, but we stress certain points concerning the relationship of the proposals to industry. That they will both relieve unemployment and increase taxation cannot be doubted. The proposals aim at the fullest and most effective use of the industrial capacity and the man power available for production of material in the country. At the recent dinner of the Staffordshire Iron and Steel Institute a speaker declared that every producer represented in the audience would be called upon to deal with orders arising from the new situation, and there is no doubt that foundries will be greatly involved. The amount of direct armament material required from foundries may not be large, and will vary in proportion in the different sections, but indirectly the amount required will be considerable. The Government calls for the most careful organisation and the willing co-operation both of the leaders of industry and of trade unions, so as to be in a position, if need arises, to change over from commercial to war production. We must not allow this change to be improvised at the last moment, as in 1914. The Government has therefore decided to create a reserve source of supply to be available in cases of emergency. A number of firms will be selected which do not normally make war stores but who are suitable by reason of possessing experience and skilled engineers and workmen. Small peace orders will provide for the necessary training in production, and arrangements will be made regarding the laying down of plant and machinery. Regarding the shortage of skilled labour, the industry concerned must make sure that vital processes are not held up for want of necessary craftsmen. Regarding costs and prices, organisation will be proposed to control prices and prevent excessive profits. With principal contractors there is not likely to be any difficulty in working on present lines, but for secondary contractors in secondary or ancillary sections of organised industry, it is intended that communications shall pass through small committees to be appointed by the trade organisations themselves. The majority of foundries will probably find themselves in this group of secondary contractors, and the implications of these suggestions will be considered in a second article.

Liquid Metal Temperatures

We are impressed with the discrepancy of the figures given as representing the temperatures to be associated with extremely hot, very hot, hot, normal, dull and very dull molten cast iron. After a conversation with half a dozen of the leading metallurgists, one receives the following advice: (1) To the figures as reported by the ordinary foundry for molten cast iron one should add about 100 deg. C. to arrive at the truth, and (2) the usual temperatures as reported for liquid cast iron should have at least 100 deg. subtracted. There is a condition which is peculiar to molten cast iron; that is, before any film has been created there is usually a globule of slag rapidly whizzing round. It is the sort of surface which, when it reflects sunlight, dazzles the eyes to an extent that makes visual inspection impossible. A second phase is the appearance of a "film," whilst a third phase (to be noted with ordinary grey iron) is usually referred to as "exhibiting break." These and perhaps other phases admit of readily understood definitions. If this be so, it appears to us that they form an excellent basis for the establishment of true temperature readings by means of the sacrifice of the thermocouples of direct-reading pyrometers. Obviously, it would be just as well that the exact composition of the metal be determined so that one could differentiate on a thermal basis, if there be such, between similar conditions in grey cast iron and, say, malleable. Some work has already been done in Germany, and is actually being utilised by one of Britain's most prominent metallurgists as a basis for the calibration of his optical pyrometers. Experiments confirming this is, to our mind, urgently needed in order that the present chaotic conditions may be straightened out. At the moment, apparently as much credence is to be given to the moulder's judgment of molten-metal temperatures as to that of the metallurgist, although in the former case the final impression of intensive heat is given by the strength of the swear-word adjective. Thus b——y hot represents a much higher temperature than d——d hot, and if this be appreciated a real comparison of temperature is afforded. Trade is certainly sufficiently brisk at the moment to warrant the wholesale destruction of thermocouples in the interest of scientific comparison of results.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Sulphur Loss in Stored Drillings

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to the discussion on the address on "Oxygen in Cast Iron and Steel," presented by Mr. P. B. Henshaw to the Sheffield Branch of the Institute of British Foundrymen, and reported in your issue of February 27, I note that Mr. T. R. Walker raised a point with regard to the estimation of sulphur in steel by the evolution method. I think the point can be answered by referring to my Paper on "Comparison of Different Methods of Estimating Sulphur in Steel," "Journal of the Iron and Steel Institute," 1921, No. 1, Vol. CIII, pages 345-347.

It is true that the sulphur content as determined by the evolution method may be affected by storage of the drillings, but not if the drillings are first carefully dried and stored in a sealed dry bottle. If the bottle is opened from time to time incipient rusting is likely to occur and the sulphur estimation will be affected. In order to obtain the true sulphur content after slight rusting has occurred, it is necessary to heat in a reducing atmosphere.—Yours, etc.,

T. E. ROONEY,
Metallurgy Department.

The National Physical Laboratory,
Teddington, Middlesex.
March 5, 1936.

Employer Co-operation

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Having carefully read your leader and the Manchester and District Association's letter on the question of Casting Prices in your issue of January 30, my company are fully in agreement with the views of both parties, but venture the opinion that there are few foundries that do not accept work of a definitely low price and are aware that with no scrap allowance there can be no chance of making a profit, but delude themselves that it helps the blow, or is useful for taking the first iron, or that spare iron can be put into the moulds made, where too stiff, etc., for better-class work, with the usual result that these moulds get poured with the general run of metal and show no saving in any direction.

The quoted prices of certain railway castings are impossible from a profit-producing point of view, and a general agreement on the costing question showing a price of metal melted would rule out many quotations. There will always be many opinions as to costing, and also difference in methods of production that will show varying price results. There should be a definitely better showing to the foundrymen as a result of co-operation with an agreed costing system as a basis. It would be a good idea to incorporate it in any scheme adopted—being a method of stabilising the intelligence of the foundry estimating department when trade falls off again, and a recipe for the foundry management, to be taken daily, in times of depression, giving them moral courage sufficient to bear up when the estimating department advise them that "so-and-so's" contract is lost on price. We recognise that there is sure to be trouble in arranging this matter, as one foundry will make provision for machine moulding of small quantities of comparatively small castings, while others are laid out in such a manner that a number of large castings, one off, can be produced by other methods than hand-ramming.—Yours, etc.,

THOMAS A. SPIERS.

Eclipse Foundry Company,
Leicester.
March 5, 1936.

Publications Received

Aluminium in the Rubber Industry. Published by the British Aluminium Company, Limited, Adelaide House, King William Street, London, E.C.4.

The non-ferrous foundry industry is once again indebted to the publishers of this booklet for giving them an insight into still another trade which they supply. The rubber industry is apparently quite important from this angle, as it absorbs a considerable quantity of the more simple type of casting alloys. The heat conductivity of aluminium makes it specially important in a good many applications. To quote from the book:—

"Formers in cast-aluminium alloy are employed for the making up and curing of a variety of goods, from Wellington boots to motor tyres, and in the latter instance it is interesting to study the reasons for the use of aluminium. The moulds themselves are usually of cast iron, and obviously such moulds complete with the design of tread would be extremely heavy, and, moreover, a large number of moulds would be required for the different types of tyre produced. It has become standard practice to-day to make the cast-iron mould simply a shell and to use inserts of cast-aluminium alloy which fit into the cast-iron mould and bear the reversed impression of the tyre tread. The inserts are cast in suitable aluminium alloy of high surface hardness to segmental shape, carefully machined so that they fit together and form the complete circle of the tyre. By having a number of sets of inserts it is possible to use the same mould for a variety of types of tyre tread. Alternatively, when there is a run on one particular design of tread, cast inserts are easily produced, and can be used with the various mould shells which are available. When a design of tread is scrapped, the aluminium inserts which are used are not wasted, but can be remelted and used again for a variety of purposes. In addition to the above facts, it should be noted that because of the high heat conductivity of aluminium, roughly three and a-half times that of cast iron, quicker curing is obtained, giving increased output."

This quotation, besides emphasising the point as to heat conductivity, gives one an appreciation of the real utility of the book, and shows manufacturers of cast iron that they too have good reason for asking the publishers to send them along a copy. To the non-ferrous side of the industry it is invaluable.

British Railway Facts. The British Railways Press Office have just issued, on behalf of the four main-line railways, the 1936 edition of the booklet "Facts About British Railways." The thirty-two pages of this new booklet are a mine of information, and contain, amongst many other interesting facts, column diagrams of railway receipts and railway expenditure, and a map of the British railways showing the routes of the famous main line expresses. The following extracts are examples of a few of the hundreds of railway facts which the publication contains:—

"There are 59 express passenger trains which run regularly on five or more days of the week at average speeds of a mile or more a minute, start to stop. These trains together cover more than 5,000 miles in 24 hours."

"Thousands of British miners are regularly employed in mining the 14,373,000 tons of coal required for the 20,165 locomotives, and steamships, hotels, offices, works, etc."

"From the British brickfields are purchased annually 21,212,000 bricks; from British mills 2,732,000 yds. of cloth; and from British steelworks 214,000 tons of rails."

Our readers can obtain copies of the booklet free of charge from the British Railways Press Office, 35, Parliament Street, Westminster, London, S.W.1.

Random Shots

One of "Marksman's" correspondents has been delving into the archives of engineering, and as a result he has compiled an interesting list of centenaries of 1936. One of the most notable personalities who would have become centenarians had they survived until 1936 was Sir John Wolfe-Barry (born December 7, 1836), engineer of the Tower Bridge, and of the railway bridges of Charing Cross, Cannon Street and Blackfriars, and of Barry Dock. He was President of the Institution of Civil Engineers. On May 1, 1836, was born Sir Theodore Fry, chairman of the firm of Sir Theodore Fry & Company, iron manufacturers, of Darlington, and M.P. for Darlington; and on the last day of the same month was born Francis William Webb, a famous civil engineer, who was connected for fifty-five years with the L. & N.W.R.

* * *

There occurs on November 2 the centenary of the birth of James Henry Cotterill, who was apprenticed to Fairbairn & Company, but was subsequently Professor of Applied Mechanics at Greenwich, and author of "The Steam Engine considered as a Thermodynamic Machine" and "Applied Mechanics." Jay Gould was born on May 27, 1836. He was one of the most famous of American financiers, beginning life in an ironmongery store, and gaining control of a great section of America's railways, becoming also founder of the Western Union Telegraph system.

* * *

Yet another celebrity born in 1836 was Theodore Cooke, who was responsible for the erection of the Bassein Iron Bridge, 4,312 ft. long, in India, and who became Principal of the Government Civil Engineering College (afterwards the College of Science). On March 13 a century ago was born Robert Bellamy Clifton, a Professor of Physics, who was from 1879 to 1886 a member of the Royal Commission on Accidents in Mines, taking an active part in the investigations involved in the prosecution of the inquiry. On July 8 was born Joseph Chamberlain, who began life in the screw factory of his relatives, the Nettlefolds, becoming a partner, and retiring at thirty-eight to become one of the most famous statesmen of the century, and the Father of Tariff Reform.

* * *

Sir Hugh Gilzean Reid was born on August 11. He was connected with the iron and steel industry, and became chief founder and first President of the Institute of Journalists, and President of the Society of Newspaper Proprietors and Managers. Another celebrity born in the same year was Frederick Wootton Isaacson, President of the Nantyglo Coal & Iron Company.

* * *

On January 28 a century ago died William Scott, Baron Stowell, who was the son of a Newcastle coal fitter, but who became virtually the founder of British prize law. Four days later John By, a famous engineer, died. He was a pioneer of canals in Canada, and his name was commemorated in "Bytown," but not perpetuated, for Bytown changed its name to Ottawa when it became the capital of the Dominion of Canada.

* * *

The sun was already approaching the meridian, when Miss Mae West yawned, stretched herself, donned her negligé and ordered her maid to prepare her bath. The brilliant sunlight, the perfume of the bath salts and the spring flowers which lent colour to her dressing room turned her thoughts from her New York flat to country cottages, fields and woods. She dawdled absent-mindedly over her toilet, and before it was half completed, she refilled the bath and indulged in a second "tub," and this is the cleanest Mae West story ever heard by a foundryman.

"MARKSMAN."

Sand- and Shot-Blasting*

By J. H. D. BRADSHAW

Sand- or shot-blasting is the term usually employed to describe a process for cleaning castings, stampings and other objects. It consists essentially of the introduction of sharp-edged quartz sand or steel grit into a stream of compressed air. This stream of abrasive and air enters a nozzle, in which its energy is converted into speed, serving to throw the particles of abrasive against the surfaces to be cleaned. Owing to their sharp edges and hardness, the abrasive produces a somewhat rough or etched effect by removing small pieces of material, during which action the abrasive itself undergoes destruction.

The origin of sand-blasting is not known with any degree of accuracy. It is, however, claimed that an observant traveller saw the commercial possibilities in the action of sand blown across the face of the Sphinx. With the historical aspect of the subject, the present Paper will not deal; sufficient for the purpose to say that, whatever the origin, it has developed into a great labour-saving industry, which provides a finish entirely unobtainable by any other method, and in addition, for some processes, is absolutely essential.

Common Applications

Some of the more common applications of the process are the cleaning of all metallic objects. Castings may be treated to remove sand, etc., while scale, grease and other foreign matter may be removed from stampings or forgings in order to produce surfaces suitable for painting, enamelling (vitreous or synthetic), plating, galvanising, rustproofing, sherardising, or metal spraying. It is also used for the cleaning of ships' hulls, the matt-surfacing of metals, roughing the handles of instruments and tools, etching of glass and marble, and for producing a rustic effect on the surface of building bricks, also on wood in order to develop the grain and give an appearance of antiquity.

As outlined above, the discharge of abrasive is usually through a nozzle, but the manner of application to the object to be treated is of many forms, in order to meet varying conditions and requirements. In some remote operations steam is used instead of compressed air, while recently-introduced machines dispense with both.

Systems Generally Used

Dependent upon the way in which the abrasive is mixed with the compressed air, three different systems can be recognised:—(1) The suction system, in which the abrasive is aspired; (2) the gravity system, wherein the abrasive falls into the nozzle by gravity; and (3) the pressure system, in which abrasive and compressed air are mixed in a chamber and the mixture subsequently carried to the nozzle.

The Suction System

In this system the discharge unit consists of a discharge nozzle projecting from one end of a mixing chamber, into the other end of which is fitted an air nipple. A suction pipe leads from the atmosphere past the sand-control valve to the side of the mixing chamber. The sand-control valve communicates with the sand bin. Pressure air is fed by a separate pipe direct to the air nipple, discharged into the mixing chamber, there depressing the pressure below atmospheric, with the result that air from the open end flows along the suction pipe, picks up the abrasive material, and carries it to the mixing chamber. There, pressure air, suction air, and abrasive are mixed, and finally expelled through the discharge nozzle. The abrasive used during projection falls on a sieve, which retains any large impurities, and from this sieve it returns to the sand bin. From the sand bin the abrasive is again drawn into the nozzle. The circuit of the abrasive is therefore a closed one, and the system is automatically continuous in operation, but, owing to the abrasive being introduced into the air stream at or near the point of discharge, the delivered pressure is actually below gauge indication, with consequent decreased velocity.

In order to minimise the production of large clouds of dust, which usually accompanies sand-blasting (using sand as abrasive), two iron sheets covered with rubber plates are sometimes placed inside the machine in an inclined position. The spent abrasive strikes these plates and falls to the bottom of the machine, where it is then out of reach of the air current. It is also important that a good exhaust is continually maintained within the apparatus in order to prevent escape of dust. The disadvantage of the suction system is that it requires considerably more power than any other blast system.

An apparatus employing the suction system is the so-called "Midget Barrel," which is particularly suitable for cleaning small articles (*e.g.*, screws). This barrel works in an inclined position, and at the bottom is provided with a perforated cone, which facilitates rotation of the work being treated. The drum itself revolves round a hollow shaft, which conducts dust and abrasive into a receiver. The dust is drawn away and the abrasive returned for further use. The advantage of this machine lies in the small space required and the facilities it offers by continually turning the work being treated.

The Gravity System

This is somewhat similar to the suction system, the chief difference lying in the fact that the abrasive is fed to the mixing chamber under the influence of gravity, additional to any suction effect. As in the suction system, the abrasive is mixed with the air immediately prior to entering the nozzle, but in this system produces more efficient operation accompanied by less wear.

The gravity system is generally employed in revolving drums and rotary tables. Drums are more economical in use and give a greater output than rotary tables. This is largely due to the fact that the articles being treated are in layers, and the ability of the abrasive to penetrate into the spaces, thereby resulting in better utilisation of the jet.

The main objective in rotating the drum is slowly to turn the objects being cleaned in order that the stream of abrasive may reach everywhere. For this reason, drums are generally designed to turn rather slowly (about 1 r.p.m.). The abrasive is sieved before entering the nozzle, and is employed until completely destroyed. It is then removed as dust and simply requires replacing with new material. This is generally added by means of a shovel at intervals. The operator has simply to fill and discharge the machine.

Another apparatus employing the gravity system is the rotary table. The table of the machine is covered with a movable iron grid, the surface of which is sprayed by one or more nozzles. In operation, the articles to be cleaned are packed closely together on the table, and after exposure to the jet are turned round in order to be cleaned on the other side. These machines generally present the inconvenience of not being entirely dust-proof, in addition to which they are not particularly efficient owing to the fact that it is practically impossible to pack the table in such a manner that open spaces are completely avoided.

Furthermore, the action of the nozzles cannot be used to their full extent on these machines, owing to the fact that the same spots are continuously being hit. In view of the above remarks, it is clear that only flat objects can be economically cleaned on rotary tables. A cube, for instance, may have to be turned six times in order to be cleaned all over. An improvement is obtained by arranging the nozzles so that they describe a circular movement in a slightly inclined plane.

An elevator is usually employed on machines working this system, to carry the abrasives to the sieves, from which it again falls to the nozzles.

The Pressure System

The best outputs are undoubtedly obtained with the pressure system, but, unfortunately, it has the great disadvantage of subjecting various parts of the apparatus, *e.g.*, abrasive carrying pipes, to excessive wear. In this system the abrasive is contained in a closed pressure chamber to which is fed pressure air, and from which a mixture of air and abrasive passes through a control valve into a pipe line in which pressure air is flowing, the whole being discharged through a nozzle at the end of the pipe.

The higher efficiency of this system is due to the fact that the abrasive itself is under pressure, whilst the great advantage of the method is that the blast pressure is not reduced by the introduction of secondary air at atmospheric pressure, which is the case of both the gravity and suction systems.

The simplest sand-blast unit for this system consists of a pressure chamber, below which is the control valve, and above which is an abrasive hopper, a hand-operated valve being placed between the abrasive hopper and the pressure chamber. When the pressure chamber has been emptied of abrasive, air must be shut off to allow the chamber to be refilled from the hopper. Therefore, continuous operating time is limited by the size of the pressure chamber. For some purposes this fact, together with the fact that time is needed to refill the pressure chamber, is not a serious disadvantage—*e.g.*, when applied to a tumbling barrel—when a batch of castings can be cleaned before the pressure chamber empties. This may, therefore, be called a non-continuous plant.

To overcome the inconvenience arising through service interruptions in the single-chamber apparatus, machines with several chambers are now being made. With these, blasting can take place from one chamber while another one is filling from the hopper.

Sand-Blasting without Compressed Air

The air consumption in the compressed-air type of machines is seldom realised, neither is the power absorbed in compressing it. Table I will illustrate both points.

TABLE I.—*Air Consumption in Sand Blasting.*

Working pressure, lbs. per sq. in.		Dia. of nozzle.		
		$\frac{5}{16}$ in.	$\frac{3}{8}$ in.	$\frac{7}{16}$ in.
30	Cub. ft. per min. ..	62	90	122
	H.p. absorbed ..	7	11	14
45	Cub. ft. per min. ..	84	122	165
	H.p. absorbed ..	12	17	24
70	Cub. ft. per min. ..	118	170	230
	H.p. absorbed ..	21	30	40

These figures show that the power consumption for compressing air for sand-blasting is an expensive item, which expense is seriously increased by the fact that the nozzles are subject to excessive wear, and when they become worn by the cutting action of the abrasive, the consumption of air is still further increased. A new principle in the design of sand-blasting

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen, Mr. A. Whiteley presiding.

machines has been introduced, for which is claimed a very substantial reduction in power consumption. This new principle embodies the use of centrifugal force, in which the abrasive is fed by gravity on to revolving blades and thrown direct upon the work to be treated, without any intervening pipe involving loss of efficiency. The stream of abrasive can be delivered in any required direction.

The advantages of the new machines may be summarised briefly in the following comparative order of importance:—

(1) The quality of work is equal to the work turned out by the ordinary compressed-air apparatus.

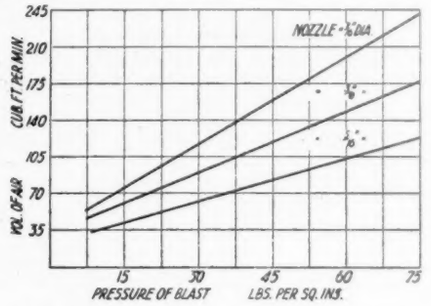


FIG. 1.—SHOWING RELATIONSHIP BETWEEN AIR CONSUMPTION AND PRESSURE.

(2) Lower power costs. It is claimed that an apparatus working two nozzles at an equivalent of 60 lbs. pressure requires only 6 b.h.p. instead of 40 b.h.p.

(3) The apparatus is practically noiseless in operation, and can be installed in a machine shop without any inconvenience.

(4) They do not require any air compressor, with its electric motor and control gear, air receiver, etc.

(5) Easy loading and unloading.

(6) Positive cleaning of abrasive—all dust and fines removed by air wash.

(7) Accessibility. All drives and bearings thoroughly protected from dust and abrasive, but easily inspected.

There are also other interesting points of comparison. For example, in the compressed-air type of plant it is well known that moisture should be eliminated as far as possible on account of its tendency to rust the abrasive medium, with clogging at the valves and nozzles.

The centrifugal-force type of machines are suitable for use with either quartz sand or chilled-steel abrasives, according to the class of work to be treated, and the same considerations apply to the selection of the abrasive as in the

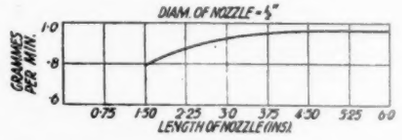


FIG. 2.—SHOWING INFLUENCE OF LENGTH OF NOZZLE ON EFFICIENCY.

compressed-air type machine. Chilled-steel abrasive is strongly recommended, however, on account of the greater output and the smaller quantity of dust made. The spent abrasive falls into a lower chamber, whence it is raised by an elevator, passed through a sifter, and into the hopper, from which it again falls on to the centrifugal throwing device. The circulation of the abrasive is completely automatic in action and leaves the operator entirely free for other work. Originally, this type of machine was only available in the barrel form, but now rotary tables employing the centrifugal principle are available.

Output of Sand-Blast Machines

The output depends on the following basic factors:—(*a*) air consumption, (*b*) air pressure, (*c*) length of nozzle, (*d*) distance between nozzle and article to be cleaned, (*e*) the angle at which the jet hits the object, (*f*) the kind and nature of abrasive, its quality, and (*g*) the system employed.

(*a*) *Air Consumption.*—The air consumption and pressure of the apparatus depends upon the interior diameter of the nozzle and the system. The relationship between air consumption and pressure and diameter of nozzle is shown on the diagram, Fig. 1. As the diameter of the nozzle is not constant, however, but enlarges with use, one of two things may happen—(1) the volume of air flow increases or (2) the pressure drops. If the latter occurs, cleaning will probably be slower; but if the compressors are capable of maintaining a constant pressure, cleaning should be quicker.

(*b*) *Air Pressure.*—In order to obtain maximum efficiency in cleaning, it is essential constantly to maintain the desired air pressure, which must be adapted to the ability of the material being treated to withstand the impact of the abrasive. Efficiency in sand-blasting depends on several factors, but, others being equal, it may be stated the higher the pressure, the more rapid the cleaning, and, broadly speaking, twice as much work may be accomplished at, say, 60 lbs. pressure as at 30 lbs.

(*c*) *Length of Nozzle.*—The efficiency of a nozzle of ½ in. dia., measured by loss of weight of articles treated, is only slightly improved by an increase of length, as is shown in Fig. 2.

TABLE II.—*Suggested Abrasives and Air Pressure for Various Cleaning Jobs.*

Type of material.	Type of abrasive	Air pressure, lbs. per sq. in.
Non-ferrous castings and objects of soft materials	Fine angular, say No. 60	18 to 20
Iron castings ..	No. 24 or 30 angular..	25 to 35
Malleable castings (annealed) ..	No. 24 angular ..	40 to 45
Steel castings ..	No. 10 or 12 angular	60 to 80
Steel stampings, forgings, plates, sections	No. 16, 18 or 24 round	45 to 60

(*d*) *Distance between Nozzle and Article to be Cleaned.*—The distance between nozzle and surfaces is of considerable importance. This is clearly shown in the diagram, Fig. 3. As a general rule, the greater the distance, the greater the area covered, but less weight is removed. It is usual to take a big distance when simply cleaning parts from grease, etc., and to work at a short distance for removing scale, etc. The position of the nozzle relative to the work for greatest efficiency depends, therefore, on the nature of the work. If an article is cleaned only with difficulty, the nozzle should be close to the work. If, on the other hand, it is cleaned with ease, the nozzle can be farther away and the abrasive allowed to spread.

(*e*) *Angle of Projection.* — The best angle of projection, using quartz sand, is 15 deg. This gave the largest area sprayed and the greatest quantity of material removed, as is shown in Fig. 4. Using No. 24 angular-steel abrasives on C.R.C.A. plate, Neville[1] found that 30 deg. was the best, and on cast iron 50 deg. With No. 24 round shot, the same investigator found that an angle of 60 deg. produced the most satisfactory results. In practice, therefore, it is recommended that the nozzle be held obliquely to the work—say, 45 deg.—not perpendicular to it.

(*f*) *Size of Abrasives.* — Regarding the influence of the size of abrasive on the output of sand-blast machines, it may be stated as a general principle that the grain may be increased in size with the hardness of the material treated and the thickness of the layer that has to be removed. For the cleaning of iron and steel castings, the best sizes are from Nos. 8 to 20, whereas thin sheet articles for enamelling are best treated with the finer grades, say, Nos. 20 to 60. The quality and class of abrasive, together with the air pressure to be used, depend entirely upon the surface of the material to be cleaned, but, as a somewhat general guide, the data in Table II are put forward.

[1] "Proceedings, Institute of British Foundrymen," Vol. XIX.

Hardness of Abrasive

Of the properties desired in a satisfactory abrasive, the one of hardness is undoubtedly the most important, but it is with regret one records that hitherto no published information is available regarding this property. There are now available several types of suitable apparatus

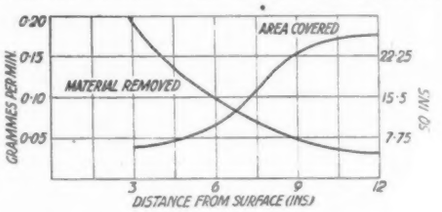


FIG. 3.—SHOWING EFFECT OF VARYING DISTANCE FROM SURFACE TREATED.

(*e.g.*, Vickers hardness tester, and the Firth Hardometer) for determining the hardness value, and the suggestion is hereby expressed that some standard method of ascertaining this value will in future be adapted.

During the manufacture of chilled-steel abrasives at the works with which the author is connected, control is strictly exercised over the hardness. Hardness determinations of individual particles of abrasive are made with the Firth Hardometer, using the diamond indenting tool. (Fig. 5.) The results of such tests indicate the Brinell diamond hardness to be from 750 to 875.

Effect of Moisture

Compressed air contains moisture, which should be removed before delivery to the sand-blast, to prevent dampening the abrasive, with consequent clogging and other troubles. This clogging is minimised by the installation of gas rings beneath the pressure chamber, whilst frequent cleaning out of the plant is practised in some works in order to overcome the trouble.

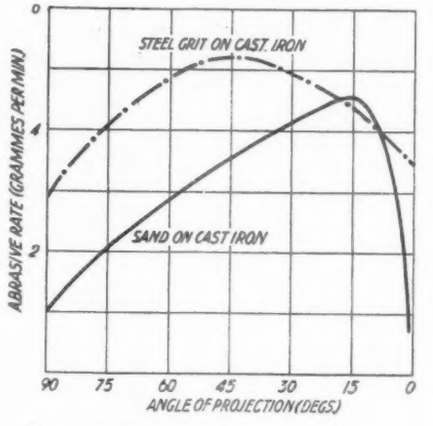


FIG. 4.—SHOWING EFFECT OF VARYING ANGLE OF PROJECTION.

It is, of course, a well-known fact that the finer grades of abrasives possess greater clogging tendencies than the coarser grades. This moisture problem has always been one of the difficulties encountered when changing from quartz to steel abrasives, which unfortunately becomes increasingly difficult with increased pressure.

Finish Obtained on Iron Castings

The finish obtained on samples of cast iron cleaned under standard conditions, but using different abrasives, has been studied by Neville,[2] who obtained the results shown in Table III.

Wear of Nozzles

This has already been briefly considered, when discussing the output of sand-blast machines, but it is of such vital importance that further reference is considered necessary. Nozzles are

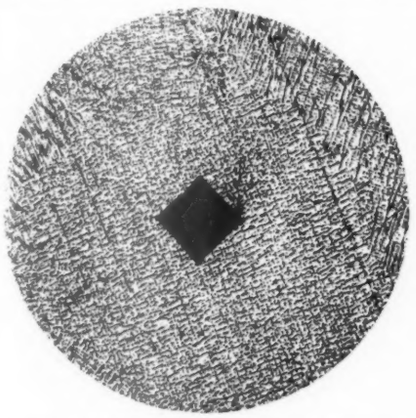


Fig. 5.—Impression on Chilled-Steel Abrasive by Firth Hardometer.

subject to wear at both the inlet and outlet, each of which has its own peculiar influence. Maximum efficiency is only maintained so long as the abrasive stream is concentrated, but efficiency is decreased whenever the abrasive stream is spread over too great an area. Nozzles worn beyond the limit of good practice are an added expense, as they increase the total sand-blasting costs by many times the price of new nozzles.

A nozzle should be changed immediately the outlet has worn to such an extent that the time of blasting is out of all proportion to the flow of compressed air and abrasive. Wear at the outlet is caused by the side thrust of the abrasive against the walls of the nozzle. This action takes place gradually from the inlet, and results in the production of a somewhat bell-

Fig. 6.—Microstructure of Chilled-Steel Abrasive.

mouthed opening, which causes the abrasive stream to spread, with its serious loss in production.

Norbide Nozzles

Nozzles are usually made of a hard white cast iron, but gas tubing is sometimes used. They are not, therefore, very expensive, but it should be emphasised, however, that they are probably one of the largest factors in controlling operating costs. There are now on the market nozzles which have a guaranteed working life of 1,500 hrs., during which time the outlet will not enlarge to more than 50 per cent. of its original diameter. They are somewhat revolutionary in shape, and the holder is incorporated with, and is part of, the sand-blast hose. The actual nozzle is turned out of mild steel and lined with an exceptionally hard material, known as "Norbide" (boron carbide, B_4C).

"Norbide" nozzles are made in all the common styles and sizes used in foundries. Their life varies considerably with different installations, depending on many factors, *e.g.*, nozzle size, abrasive material used, and air pressure. The standard guarantee at pressures not exceeding 90 lbs. per sq. in., is that wear at the outlet end will not exceed 50 per cent. of the original orifice diameter for a period of 200 hrs. with aluminium-oxide abrasive, 750 hrs. with silica sand, and 1,500 hrs. with chilled-steel abrasives. Owing to the fact that the opening in a "Norbide" nozzle remains practically constant in size for a long time, air consumption is considerably decreased. Some users report that they are able to lower the setting of their compressor by 10 lbs., and in addition there is a saving in the volume of air consumed. Owing to the opening in a "Norbide" nozzle retaining its true cylindrical shape and size, the abrasive stream remains concentrated, and therefore the abrasive velocity does not drop.

Metallic or Non-Metallic Abrasives

The possibilities of using chilled-steel abrasives have during recent years been very much discussed. Broadly, the question may be considered from two angles, and, for lack of a better description, they will be called (*a*) the hygienic and (*b*) the economical aspect.

Table III.—*Finish Related to Abrasive* (*Neville*).

No.	Abrasive.	Finish.
1	Fine steel grit ..	Bright silver grey
2	Coarse steel grit ..	" " but etched surface.
3	Fine steel shot ..	Dull, smooth surface.
4	Coarse steel shot ..	Dull etched surface.
5	Quartz sand	Etched, not so bright as with fine steel grit.

(*a*) *Hygienic.*—It has already been suggested that sand or some form of siliceous material was the original medium used for sand-blasting; hence the name. In use, this sand disintegrates into a very fine dust, which, inhaled into the human system, produces that dreadful disease, silicosis, for which there is no cure. This is, indeed, a disease to be feared, and every considerate factory executive having the welfare of his workers at heart will welcome the Home Office suggestion to suppress wherever possible the use of any materials that contribute to its cause.

If one reviews very briefly some of the published statistics regarding deaths from this cause, it will be seen that the Home Office regulations are, in the interests of humanity, quite justified.

In a Paper presented to The Institute of Vitreous Enamellers last year, on the subject of "Silicosis," Dr. Middleton (H.M. Medical Inspector of Factories) made the following statement:—"It was not possible to estimate accurately the effect of the disease, but reliable sources indicate that over 300 deaths occur every year in England and Wales from this cause. The disease progressed slowly, and some degree of disablement appeared long before it proved fatal. Over £100,000 was paid in compensation in a single year in this country." Dr. Middleton further states: "There was no remedy for the disease once the lungs have become affected. The only alternative was prevention, which could be effected by:—(1) Avoidance of injurious materials; (2) suppression of dust at its source; (3) removal of dust as near as possible to the point of origin; and (4) protection of the workman."

Of the four suggestions made by Dr. Middleton, the one to be most successful is undoubtedly the first, viz., the avoidance of all injurious materials. In this respect, the sand-blasting industry is very fortunately placed in so far as an efficient and economical substitute for the dangerous sand is to be obtained, and it is with pleasure one records that the majority of works to-day use chilled-steel abrasives.

Fig. 7.—Surface obtained by Blasting with Sand.

In a Paper recently read before the British Works Management Association on "Health in Workshops," the Medical Officer of Health for Coventry (Dr. Massey) quoted the following figures for the City of Coventry for the year 1934:—Death-rate from pulmonary tuberculosis among the general population was 0.77 per 1,000, and death-rate from pulmonary tuberculosis among sand-blasters was 23.2 per 1,000.

(*b*) *Economics.*—From an economical point of view, the use of chilled-steel abrasives is distinctly advantageous. Although more expensive in first cost, they have from 10 to 20 times the life of sand, while their use avoids the immense dust formation, and other risks are considerably reduced. For some purposes they have a life as high as 60 times that of sand. On the other hand, when cleaning castings for enamelling purposes, it is usually estimated that 1 ton of

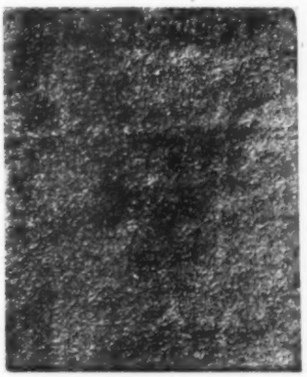


Fig. 8.—Surface obtained by Blasting with Chilled-Steel Abrasives.

a suitable chilled-steel abrasive will do the work of 16 tons of quartz. Large storage bins are therefore unnecessary, while large tonnage can be stored in a small space by stacking the bags or containers, one on top of the other.

The weight of chilled-steel abrasives is approximately 2½ times that of an equal volume of quartz; therefore, a pressure double that used for sand must be employed in order to

[2] *Loc. cit.*

obtain equal production. With sand the pressure used is generally from 10 to 30 lbs., whereas chilled-steel abrasives are usually worked with 25 to 60 lbs. per sq. in., while pressures as high as 90 lbs. are not uncommon. If one considers the action of sand-blasting, one readily realises that at each impact a certain amount of abrasive is pulverised and taken away as dust by the exhaust fan. Sand, owing to its crystalline structure, very rapidly disintegrates, and as a consequence a great amount of dust is generated.

According to tests made a few years ago by Neville, Leighton Buzzard sand loses 10 per cent. of its weight per impact at a pressure of 15 lbs., whereas No. 24 chilled-steel angular abrasive at the same pressure only loses one-tenth of 1 per cent. of its weight per impact. Therefore, despite its comparatively high initial cost, it is more economical than sand.

Metallic abrasives differ from all other natural abrasives (*e.g.*, emery, sand or quartz) in that each grain is a solid homogeneous mass, devoid of cleavage lines. Owing to this property, metallic abrasives do not break up readily on impact, they simply wear away. On the other hand, mineral abrasives have cleavage. They are built up of a large number of minute crystals held together by a common bond. On impact, such crystals disintegrate very rapidly. This disintegration proceeds until all cleavage lines disappear and the abrasive is reduced to a useless condition. In the meantime, production is hampered and costs are increased by the production of large clouds of dust.

The replacement of sand by chilled-steel abrasives for general purposes, *e.g.*, removal of foundry sand, scale, etc., has now become almost universal, but considerable opposition to its use still remains in a few isolated plants engaged on cleaning castings prior to vitreous enamelling. The principal objections raised are: (1) steel shot produces a "peened" surface, to which the enamel will not adhere perfectly, and (2) the tendency of certain acid-resisting enamels to blister when fused on castings cleaned with chilled-steel abrasives.

"Peening"

The production of a peened surface is entirely avoided by the use of an angular abrasive of fairly large size, which produces the etched surface so necessary for successful enamelling. This is clearly seen by an examination of Figs. 7 and 8. Fig. 7 is a macrograph of a sample of an ordinary cast-iron plate prepared for enamelling by means of a sand abrasive, whilst Fig. 8 is of an identical sample prepared by using a chilled-steel angular abrasive. The surface obtained by the latter is probably too rough for enamelling by the wet process, but the result obtained is a maximum one, and by varying either the pressure of the compressed air or the size of the abrasive, it is possible to produce a large range of surfaces.

Blistering

The tendency to blister exhibited by some enamels is due to what is sometimes termed "metallic smudge" and its presence is due to inefficient cleaning of the abrasive in the plant. This foreign matter has in the past been erroneously called "graphite carbon." In order to remove the foreign matter, and thereby prevent blistering, the use of an abrasive cleaner and separator is strongly recommended.

Conclusions

It may be said that (1) sand-blasting will remove scale, rust, etc., and will give an article a surface particularly suitable for painting, lacquering, enamelling, etc. It is universally agreed that enamel will adhere with considerably greater tenacity to a sand-blasted, than to a non-sand-blasted surface, and in addition, a more uniform covering is obtained. Less paint is required to give a satisfactory film, which if applied immediately after sand-blasting, will have a much longer life, owing to prevention of oxidation. (2) Fused sand and embedded particles are removed from the surface, thereby preventing damage to tools in the machine shop. (3) Dust from cores, etc., is readily removed without spreading over the foundry, and (4) it is much less costly and far more convenient than the old-fashioned pickling process.

It has also been shown that chilled-steel abrasives can successfully replace sand or quartz in order to achieve any of the above named results. To anyone considering a change from non-metallic to metallic abrasives, however, it should be pointed out that a sand-blast operator who is only familiar with the use of flint grit cannot be expected to produce first-class results immediately a change-over is made. He has to become accustomed to the new material, which may require slight alteration of the conditions under which the plant was formerly operated.

Finally, the author tenders his thanks to the Directors of Bradley & Foster, Limited, for permission to give the Paper.

Book Reviews

Cast-Iron Pipe, Its Life and Service. Published for private circulation by the Stanton Ironworks Company, Limited, near Nottingham.

Accelerated tests to destruction may appeal to the mathematically-minded engineer, but performances based on surveys going back a few hundreds of years are indeed impressive. For two and a-half centuries water undertakings have largely relied on cast iron for their conduits. Before then ceramics (by the Greeks), lead (by the Romans) and wood (by many nations) were used, whilst still earlier recourse was made to canalisation and aqueducts. Ancient Rome had fourteen aqueducts, the largest being the Marcia, which was 58 miles long and was capable of delivering 78,256,000 galls. daily. A most fascinating account is included of the history of Dublin's water supply from A.D. 1255 to 1809. Founders will be interested to learn that in 1776 "quotations were invited from the Carron Company of Scotland, Mr. Wilkinson of Brosley, and Abraham Darby of Coalbrook, for cast metal pipes 8 ft. in length, 12 in. in clear bore and ½ in. in thickness and flaunched at each end." After Dublin comes London, but it does not attain the same level of interest.

The next section of the book deals with the early history of wrought and cast iron and the development of cast-iron pipe from the middle of the seventeenth century to the inception of the centrifugal system. Stanton was the first to do this on a large scale in 1922.

Chapters IV and V are a collection of interesting notes supplied by the engineers attached to widely-dispersed municipalities dealing with the serviceability of water mains when made of cast iron. Chapters VI and VII cover the field for gas mains. The situation in France and America is surveyed in the final sections of the book. A lengthy appendix sets out alphabetically the age and condition of the mains under a very large number of cities and towns in Great Britain.

The book is of great historical interest and the publishers are deserving of the thanks of the foundry industry for the admirable and dignified way they have advertised the corrosion-resisting properties of cast iron.

V. C. F.

Boiler Feed Water Treatment. By F. J. Matthews, B.Sc. (Hons.). Published by Hutchinson's Scientific & Technical Publications, Paternoster House, London, E.C.4. Price 12s. 6d. net.

This complex subject is dealt with very exhaustively. Although the author, in his preface, makes reference to the small operating engineer, the book generally is far too academic in character to come within his scope; it is essentially a work which can only receive the measure of appreciation it deserves in the hands of the chemist and the advanced student of boiler-house practice.

The author does not propound any new theories regarding feed-water troubles, neither does he suggest any alternative to the standardised methods of eliminating those troubles. Rather is the work a masterly assembly of recognised factors established by analysis and research, enriched with valuable observations and lucid explanations, combined with a wholly impartial consideration of the several types of water-softening plants.

The book is conveniently divided into five parts. Part 1 deals with water supplies, and in this section the author makes a point, which is perhaps not generally recognised, that even rain water, admittedly the purest supply available, will require a certain amount of treatment. In Part 2 scale formation and the methods available for its prevention are dealt with at considerable length. In this part also reference is made to condensate as feed water, the author pointing out that it is essential to remove its acid content before it should be used. Part 3 is devoted to a consideration of the various causes and contributory factors to corrosion, and the preventive means available.

Foaming and priming are dealt with in Part 4. The author points out that the terms are not interchangeable; as, however, the results are much the same in either case, the term "priming" is used to cover all the conditions. The data embodied in this part of the work make valuable reading for all those in charge of boiler plants, as it is full of helpful suggestions expressed in the simplest possible manner. Part 5 is devoted to a consideration of analysis and routine testing, every phase of the issue being lucidly explained. The author is doubtless correct when he states that a daily analysis should be made of the raw water. Clearly, however, that is not commercially practical, except in works where a chemist is employed. The small steam user has to content himself with a simple test, more or less approximate, of the treated water. In the Appendix, Standard Solutions, Reagents, Clarke's table of hardness and chemical factors are given.

This book may well become a standard work on the subject with which it deals.

P. F. A.

World's Largest Bridge

The scheme for spanning the San Francisco-Oakland Bay by means of a bridge, which will be nearly five miles long, is nearing completion. The cable used could girdle the earth three times and the steel required represents 7 per cent. of the entire output for U.S.A. in 1933.

These popular comparisons give some idea of the immensity of the project. Not the least important has been the preparation of the harbour bed beneath this expanse of water. One of the dredges used for this purpose is said to be the largest suction dredge in the world using shore power, and its 400,000-h.p. operating equipment makes it the most powerful dredge of any type.

For the casting of the dredge-pump casing an alloyed iron was selected containing 1½ to 2 per cent. nickel, and ½ per cent. chromium. The casting weighs over a ton, and special care was taken in the design, and in choosing the materials for it in order to ensure a long life and freedom from failure in the strenuous service to which parts of such a heavy-duty, high-powered machine are necessarily subjected.

Irons of similar composition have been used successfully in many important dredge-pump installations, and the performance of this pump shell in the severely abrasive surface to which it is exposed was fully up to expectations.

The Foundry Department of a Modern Steelworks

JOHN SUMMERS & SONS, LIMITED, OF SHOTTON

John Summers & Sons, Limited, whose works—the Hawarden Bridge Steelworks, at Shotton, near Chester—cover many acres, are one of, if not the largest sheetmakers in Europe. The firm is to-day, as indeed it always has been, a family concern, all the directors, with the exception of Mr. Walter Summers, brother of the chairman, being whole-time servants of the company. The late Mr. John Summers, father of the present chairman, laid the foundations for the business in 1850, when he established himself in a small works at Stalybridge for the manufacture of clog irons. In 1851 he purchased a nail-making machine at the Great Exhibition and commenced the manufacture of cut nails. He was singularly successful from the very outset. In 1869 he commenced the rolling of sheets from puddled iron, installing, at the Stalybridge Works, puddling furnaces, a steam-hammer and rolling mills. The manufacture of galvanised corrugated sheets was commenced at the Stalybridge Works in 1894.

The expansion of the business was consistently rapid, necessitating extensions which speedily filled the whole of the available site at Stalybridge, and a new site had to be secured which would not only meet the immediate need for expansion but also make adequate provision for future requirements. The company purchased a considerable area of land at Shotton, near Chester, and distant about 12 miles from Liverpool on the Great Central Railway. Water transport is also available and boats up to 250 tons can be loaded or discharged at the company's private wharf. Further, Shotton is conveniently placed for the supply of the raw materials.

The site was acquired in 1895, rolling mills and a galvanising plant were erected and operations were commenced a year later. At this time, puddled iron had, of course, been replaced by steel; a few years later steel furnaces and a bar mill were erected, and they commenced to work in 1902. Frequent extensions were made, alike to buildings and plant, to meet the growing demands.

A View of the Foundry Offices, etc., at the Hawarden Bridge Steelworks of John Summers & Sons, Limited, at Shotton, near Chester.

Extensions during the War

During the war practically the whole output of the works was on government account and in order to meet the demand of steel for shells a second steelworks was erected, thus more than doubling the output capacity of the works. It is worthy of note that steel was being made in the new works in less than twelve months from the cutting of the first sod, an achievement for which those responsible may feel justly proud.

Subsequent to the war, in order to consolidate the business as also to ensure an adequate supply of the necessary raw materials, amalgamations were entered into and various businesses were acquired. Amongst the more important of the subsidiary companies mention may be made of the Shelton Iron, Steel & Coal Company, Limited, who supply practically the whole of the pig-iron and the major portion of the fuel; the Wolverhampton Corrugated Iron Company, Limited, to whom the Hawarden Bridge Works supply the whole of the raw material for an output of 125,000 tons of sheets per annum, and the Castle Firebrick Company. They have also large investments in galvanising plants in the Argentine and Chili. The original works are retained, their manufactures being confined to hoop iron and nails, the raw material for which is, of course, supplied by the Shotton Works.

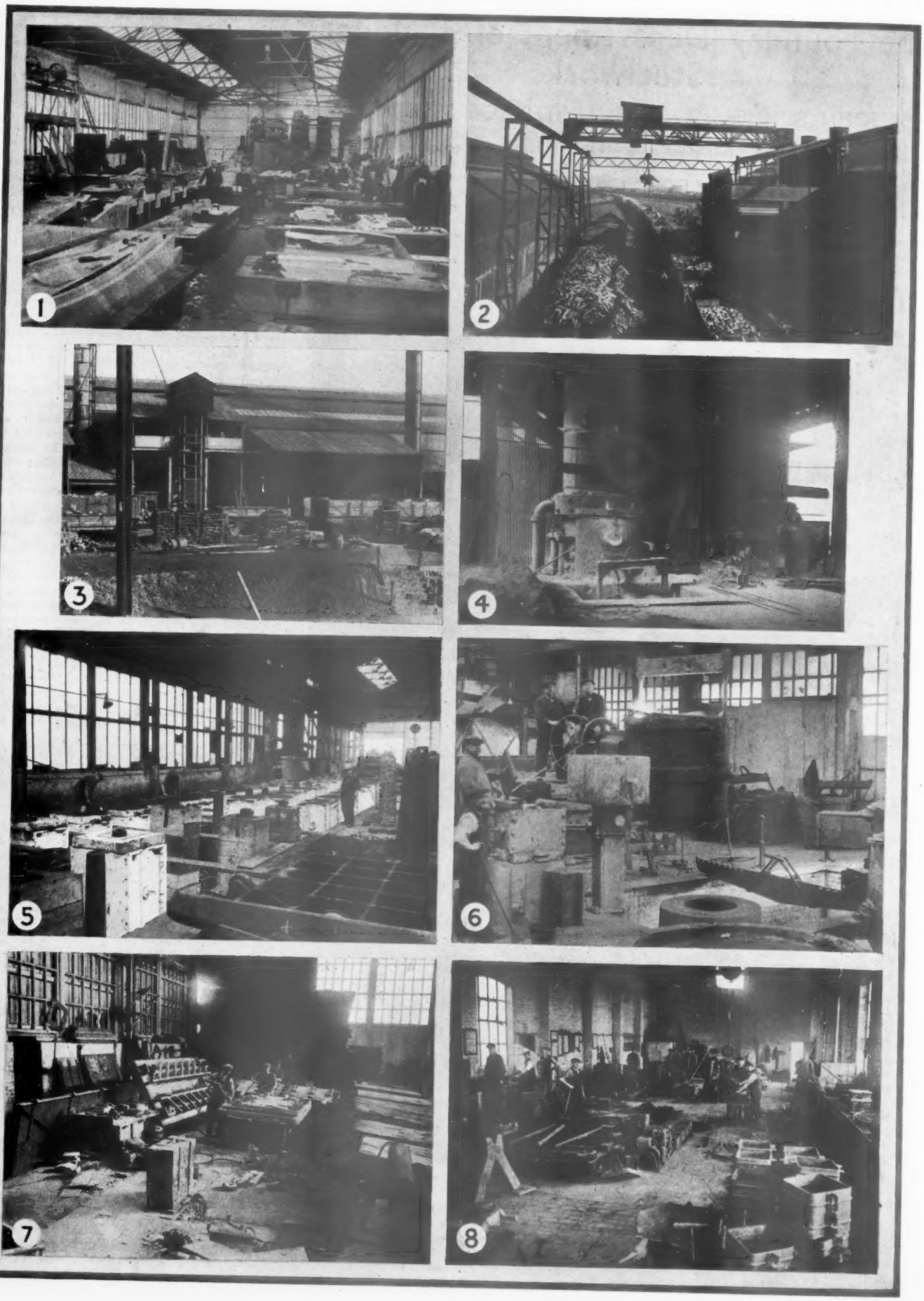
Changing Demand

The major portion of the galvanised corrugated sheets is on export account, whilst the black sheets practically all go into home consumption. With other countries becoming large producers of galvanised corrugated sheets, a serious falling-off in demand for export was to be expected and has, indeed, been experienced; at the same time the demand for black sheets has expanded very considerably; specifications have, however, become more exacting. The company, therefore, were called upon, on the one hand, to find an outlet for their production of raw material to replace the restricted demand for corrugated sheets, and on the other hand to reconstruct their sheet mills to enable them to compete in the best markets for high-grade black sheets. With that enterprise which has been characteristic of the concern since its inception they have accomplished both purposes.

The sheet mills have been entirely reconstructed to bring them well into line with the best modern practice and enable them to meet the demands for black sheets for widely-different purposes, each purpose calling for sheets specially made for the particular duty, and the mills now turn out a general-purpose black sheet one-pass cold-rolled, panel sheets, a black sheet dead flat, which is manufactured in three grades—furniture quality with an oxidised finish, polished and dead flat; sheets for hollow-ware in both pickled and non-pickled finish; enamelling quality specially prepared for vitreous enamelling; drum sheets which are capable of withstanding double seaming, etc.

Full descriptions of the various melting shops, rolling mills, galvanising plant, etc., have

A General View in the Ironfoundry Department.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appeared in recent issues of our associated journals, the "Iron and Coal Trades Review" and "Sheet Metal Industries."

THE FOUNDRIES

A foreword in connection with the foundries may not be out of place. There is little suggestive of a foundry in the half-timbered building surrounded by rock garden, border and grass patch in which the foundry manager's offices, administrative department and laboratory are housed. Mr. F. E. Hampton, the foundry manager, has a very real appreciation of the value of cultivating a co-operative spirit amongst the workers. Amongst other things, he organises an annual dinner for the workers. The last event took place towards the end of last year, when the chairman of the company, Mr. H. H. Summers, and the other directors were amongst the guests. This is an example which might well be emulated. During a year's working it is inevitable that certain differences will arise between the men themselves, the men and the officials, or between the officials themselves. At this annual gathering they meet upon a common footing, and so will come to the conclusion that the other man is not half such a bad sort as he was thought to be; troubles will be forgotten and a spirit of friendliness be generally restored. Certainly one would not wish to see a happier group than that engaged in the foundries at Hawarden Bridge Works.

The offices and their surroundings are, however, not just so much window dressing, for it is seldom one sees a foundry and its surroundings characterised by such neat orderliness. The yards and sidings are clean, and the keynote is "A place for everything and everything in its place." In the foundry itself the same orderliness is in evidence; the gangways are paved and they are kept clear. One may wonder for just how much saving in time this simple expedient is responsible; it must be very considerable.

General, Roll and Ingot-Mould Foundries

In the general foundry castings are made from 8 ozs. up to 28 tons in weight, and include slag ladles, mill housings and all castings for maintenance. In the roll section of the foundry chill rolls are made from 3 cwts. up to 15 tons in weight, grain rolls, part-chill rolls and alloy rolls of all commercial sizes. A portion of the foundry floor is laid off for the moulds for steel castings; these moulds are conveyed by bogies to the steelworks and, after casting, are returned to the foundry for fettling and finishing. There is a large casting pit and three roll pits; all moulding is done by hand. An interesting feature is the lining of the moulds for special rolls with iron bricks.

In all there are some eight ovens, all of which are fired on the British Hermann system, which has proved alike efficient and economical. Included in the foundry equipment is a vertical boring machine for boring the chills for chill rolls, and three roll lathes, all rolls being turned ready for grinding before leaving the foundry.

Fettling is carried out at one end of the foundry bay, the equipment including a full installation of pneumatic tools, oxy-acetylene cutting and welding apparatus, sand-blast plant, etc. The necessary power for the pneumatic tools and sand blast is furnished by two Jackman compressors working at 100 lbs. per sq. in.

In the ingot-mould foundry, casting is done in a pit, ingot moulds being made of all sections for works' use, as also for the subsidiary companies, the output being approximately 200 tons of finished castings per week.

Melting Plant

The melting plant comprises two cupolas, each of 70 tons melting capacity per day. These have a common charging platform, are blown by Roots blowers, and worked alternatively. Pig-iron is brought by boat, transferred to wagons at the wharf and discharged at the foundry by crane either to the furnace platform or into stock. Coke, limestone, etc., brought in by rail is also handled by the crane. The cupolas are hand-charged, only three men being engaged for this duty, two chargers and the cupola man. A third cupola of an approximate capacity of 50 tons per week, which is laid off for special irons, is served by an electric hoist. The cupolas are equipped with receivers, and from these the metal is tapped into ladles of from 5 to 15 tons capacity, which are travelled on bogies to the casting points.

Metal for the high-class alloy rolls is brought down in two reverberatory furnaces of Summers patent design, of 15 tons and 10 tons capacity respectively.

Brass Foundry

In the brass foundry, mill and other bearings are cast, white-metal-lined bearings, nickel-chrome fingers for close-annealing furnaces, and general castings on maintenance account. The shop is served by two 30-cwt. cranes. The melting plant comprises two 600-lb. Morgan furnaces and two pit furnaces for nickel chrome; there is the usual complement of cutting-off and grinding machines.

The total output of the foundries is 500 tons of finished castings per week; an output of 525 tons has actually been obtained. The pattern-shop is a well-lighted, roomy shop, equipped with a full range of the most modern type of wood-working machinery.

Description of Photographs of the Foundry Department of John Summers & Sons, Limited

(*See facing page.*)

(1) View in the Patternshop.

(2) The Cupolas, Pig-iron Yard and Magnet Crane.

(3) Cupola and Pig-iron Yard.

(4) Cupolas (70 tons capacity a day) in the Ingot-Mould Section.

(5) General View in the Ingot-Mould Foundry.

(6) Preparing to Cast a Chill Sheet Roll.

(7) Section of Fettling Department.

(8) View in Brass and Nickel-Chromium Foundry.

The Institute of Vitreous Enamellers

ELECTION OF NEW MEMBERS

At a meeting of the Council of The Institute of Vitreous Enamellers in Birmingham, recently, the following were elected to membership:—

As Subscribing Firm.

Whittaker Bros. (Accrington), Limited, Pioneer Works, Accrington, Lancs. (Representative: Mr. John Pell.)

As Associate Members.

Mr. Stanley Robert Field, analytical chemist and metallurgist, Vitreous Enamelling Company, Limited, Rushey Lane, Tyseley, Birmingham.

Miss R. P. Gracey, Sterling Manufacturing Company, Cubitt Town, London, E.14.

Mr. P. F. Waddell, analytical chemist, Forth & Clyde & Sunnyside Iron Companies, Limited, Falkirk.

Mr. Fred Clements

BESSEMER GOLD MEDALLIST, 1936

Mr. Fred Clements, director and general manager of the Park Gate Iron & Steel Company, Limited, Rotherham, has this year been awarded the Bessemer Gold Medal, which is recognised as the highest honour within the gift of the Council of the Iron and Steel Institute. Mr. Clements, in addition to the active part he has played in the development of the Park Gate Works to their present high standing among producing plants, has gained recognition as an expert in the iron and steel industry, and his opinion is sought as a consultant in many directions. His influence on technical progress, however, has been international by his contributions of the results of industrial research to the Proceedings of the Iron and Steel Institute. These were deemed in this country, and even to a greater extent in Germany and America, to introduce a new line of attack on industrial problems which has been followed since with considerable success.

In 1929 Messrs. Benn Bros., Limited, published, in three volumes, his work entitled "Blast-Furnace Practice." This study, which reviewed the process of pig-iron manufacture in all the producing countries of the world, has had a wide circulation both at home and abroad. It is regarded as one of the most important additions to technical literature in this generation. Mr. Clements, who contributed articles to the last edition of the "Encyclopædia Britannica," is a member of the Council of the Iron and Steel Institute. He is also a member of the Industrial Research Council of the British Iron and Steel Federation, being chairman of the Blast-Furnace Committee of that organisation. He is a Freeman of the Company of Cutlers in Hallamshire in the County of York. He is a member of the Institution of Civil Engineers and the Institution of Mechanical Engineers, and an associate member of the Institution of Electrical Engineers.

Mr. Fred Clements.

Catalogue Received

Vitreous Enamelling Furnaces. The British Electric Development Association, of 2, Savoy Hill, London, W.C.2, has prepared a special brochure (No. 6) which is entirely devoted to the use of the electric furnace in the vitreous-enamelling trades. This booklet is particularly acceptable as no reference is made to the various makers, and thus it assumes a little more authoritative standing as it speaks for a group. All the technical advantages are nicely set out, whilst the illustrations are particularly clear. It is available for our readers on request.

Electric Furnace Practice

A revival of interest in electric furnaces as melting media for foundry work is taking place. Just recently we have published two Papers—one by Mr. T. R. Walker and Mr. C. J. Dadswell,[1] which was recently read before the Sheffield Branch, and the other by Mr. A. G. Robiette[2] before the London Branch of the Institute of British Foundrymen. The reaction of the two centres to the subject made such interesting comparison that we have decided to print them in sequence.

THE LONDON DISCUSSION

Adaptability to Quantity Production

The BRANCH-PRESIDENT (Mr. F. O. Blackwell) agreed with Mr. Robiette that electric melting furnaces were most useful for jobbing foundries; but in regard to their application to mass-production foundries, he asked what sort of figure the author had in mind as representing the total metal tonnage requirements of such a foundry. The Branch-President pointed out that his particular foundry required 15 tons of metal per hr. continuously for 5 hrs., and he was interested to know where the electric furnace would stand in relation to that figure.

Commenting on the author's reference to the adaptability of the electric furnace for use in pouring moulds on a conveyor, he said that at his foundry there were two conveyors, and a very serious amount of time and thought had been devoted to experiments in the pouring of moulds on those conveyors, either direct from the cupola spout or from a large container. Such attempts had always failed most lamentably, for the reason that very light castings were being made, and there was a good deal of dependence on the man who was pouring the moulds. The Branch-President asked what weight of castings could be poured direct from the spout into moulds on a conveyor plant.

Basic Linings for Rotary Furnaces

MR. C. H. KAIN (Past Branch-President) described the Paper as the most interesting and informative that had been presented to the London Branch for a very considerable time, and expressed gratitude to Mr. Robiette for having dealt with the subject so thoroughly. Perhaps, however, Mr. Robiette could be persuaded not to say too much about the point he had made concerning the making and delivering of castings within 12 hrs., because if that came to the knowledge of some customers there might be difficulties!

With regard to the statement that a basic, acid or neutral lining was used in the rocking or rotating furnace—Mr. Kain assumed that the rocking furnace was a form of rotating furnace—he asked what was the type of the basic lining, for he had never yet found a basic lining which would stand up to the conditions in that furnace. His experience with that particular type of electric melting was confined solely to the melting of cast iron, and he asked what limits of total-carbon control Mr. Robiette attained when making cast iron synthetically from steel scrap. In his own experience of the use of several types of electric furnace, particularly the direct-arc furnace, carbon control at over 2 per cent. was exceedingly difficult, and it was very much affected by silicon additions.

Current Consumption Queried

Commenting on the statement that the consumption of power for melting and superheating cast iron generally varied from 550 to 650 kw.-hrs. per ton, he said that that figure seemed to be very low indeed, and he would expect the power consumption to be from 650 to 750 kw.-hrs. per ton. It was to be noted that Mr. Robiette could buy current for 0.5d. per unit, but it was difficult to buy it at that price, particularly in the South of England.

In regard to costs, reference was made in the Paper to a melting loss of 3 per cent., which was very low indeed. Mr. Kain asked exactly how that was attained, and what type of charge and type of furnace were used; in his own experience the melting loss was frequently considerably higher. The figure of £2 7s. 2d., which was given as the melting cost, was staggering, to say the least; he imagined that the cost of electrically-melted metal in this country must be at least three or four times that amount.

One of the advantages claimed for the electric furnace was that it enabled a lower-grade pig-iron to be used. The use of lower-grade pig-irons, however, usually meant producing high-phosphorus irons, or irons containing more phosphorus than usual, and he could not see any advantage in melting high-phosphorus or even medium-phosphorus iron in the electric furnace, because he did not think that any great advantage accrued to the mechanical properties of high- or medium-phosphorus iron by superheating.

Superheating—A Mixed Blessing

The figures of 1,600 deg. as superheating temperature, and 1,500 deg. as the possible pouring temperature, given in the Paper, Mr. Kain suggested, were at least 100 to 150 deg. too high. Superheating was by no means an unmixed blessing; and he believed that the Paper by Piwowarsky, read before the Sheffield Conference of the Institute some years ago, had resulted probably in the production of more scrap castings in this country than had anything previously published. As Mr. Kain had had electric furnaces at his command he had superheated the metal to 1,600 and 1,650 deg., and had experienced considerable trouble. For instance, the sand problem became very serious immediately one used pouring temperatures above 1,400 deg.; further, there was very considerable difficulty in maintaining a uniform structure in the iron, in that numerous chill effects arose due to differential cooling and quenching through the critical range, resulting from high initial temperature and also the superheating of the sand. It was Mr. Kain's experience that in measuring high metal temperatures there was a possible error of between 100 and 200 deg. C. in the pyrometer readings; he had been to considerable trouble in an effort to find a pyrometer which would measure accurately the pouring temperatures of metals, but he could not find one which was accurate within 100 deg. at temperatures above about 1,250 to 1,300 deg. C. Pouring temperatures and bath temperatures of 1,500 deg. were claimed frequently, but he, personally, was convinced that in the cases referred to the temperatures were rarely more than 1,400 deg., because a bath of metal containing 2½ per cent. of carbon or more if heated above 1,480 to 1,500 deg. in an open high-frequency furnace, in which the heating conditions were almost ideal, was almost unbelievably liquid, and the glare and whiteness were such as to hurt the eyes; such metal was much more painful to the eye when one looked at it than was liquid steel, and one very rarely saw it in a foundry, and certainly not from any ordinary melting furnace.

Hardness Control

One was rather alarmed by the statement that it was possible to control the hardness of a series of castings, melted by the electric furnace, to within limits so narrow as 13 points Brinell—between 203 and 216. Quite a number of people claimed to be able to hold the hardness to within fairly narrow limits, but he would consider it quite impossible to control it to within 13 points, even when melting metal in electric furnaces.

Whilst Mr. Kain agreed that some advantage was to be gained in the production of black-heart malleable iron by superheating—and he considered superheating to be heating to any temperature above about 1,350 deg.—he suggested that the benefit derived from so doing must be neutralised very largely by the annealing temperature of 950 deg., in spite of the excellent figures Mr. Robiette had given. It was common experience amongst black-heart malleable-iron manufacturers in this country that annealing temperatures above about 880 to 900 deg. gave rise to a rather coarse structure and a corresponding decline in properties. It was rather surprising that Mr. Robiette had claimed such very excellent properties in the metal when using such a very high annealing temperature.

Specific Gravity of Electric Cast Iron

Another question was whether MR. ROBIETTE had made any specific-gravity determinations on his electrically-melted cast iron, because Mr. Kain had found that the most outstanding characteristic of well-made electric-furnace grey cast iron was its very high specific gravity; he presumed that it was due to freedom from gases, and that the excellent properties of electrically-melted cast iron were due to that factor. In referring to high properties, he meant that an electric-furnace cast iron of 20, 22 or 23 tons tensile strength in a 0.564-in. bar machined from 1⅛-in. dia. bar ought always to give a repeated impact value of not less than about 3,000 blows, whereas a good cupola cast iron of similar composition would rarely approach 1,500 blows.

Voltage for Melting Cast Iron

MR. V. C. FAULKNER (Past-President of the Institute and of the Branch) recalled that the first lecture he had delivered to the Institute, about 20 years ago, was on the subject of electric melting furnaces, and at that time absolutely no data were available on the subject to the manufacturer of cast iron. He remembered having had some practical experience at that time of melting cast iron in an ordinary Electro-Metals furnace; the voltage available at that time was unsuitable, and it was found that actually more units of electricity were required to melt a ton of cast iron than to melt a ton of steel, because around the holes made by the electrodes there was a refractory wall, probably of graphite, and one had to resort to puddling in order to secure a suitably fluid metal. He gathered that nowadays much higher voltage would be used; and in this connection he uttered a word of warning, because high-voltage current was inclined to create excellent conditions for the fixation of nitrogen, and he had seen steel spoiled by the formation of nitride needles in the microstructure. Therefore, he asked whether such conditions could obtain in cast iron.

The first attempt to make cast iron commercially in the electric furnace in England was probably made at Darlington, using a Snyder furnace; and at an exhibition held in 1922 or thereabouts the members of the London Branch had been astounded to see tensile test-pieces giving results of 19 tons per sq. in., which at that time was considered excellent.

Removable Roofs for Charging

The use of a removable roof was interesting, but Mr. Faulkner was not impressed as to its superiority. The dumping of cold charges into a hot furnace would tend to reduce the life of the roof very considerably. The use of water-cooling was also referred to; but British foundrymen and metallurgists in general were not enamoured of water-cooling. It accounted for a good many units of electricity per ton of metal melted; and he recalled that Mr. Lake, who had once water-cooled his original low-powered furnace, had found that it had refused to melt steel at all, a fact which indicated the large amount of heat which could be lost as the result of water-cooling roofs.

1 FOUNDRY TRADE JOURNAL, February 20, 1936.
2 FOUNDRY TRADE JOURNAL, February 27, 1936.

Scrap Replacing Pig-Iron

Commenting on the author's emphasis of the use of cheap scrap in electric melting furnaces, Mr. Faulkner said that during the last 30 years every metallurgical invention had been in the direction of replacing pig-iron by scrap, and the stage had been reached at which, in various places, scrap was more expensive than pig-iron. Therefore, he commended the attention of the electric-furnace makers to the orientation of their processes to the use of pig-iron, for there was likely to be a real field for that. In the very first casts of electric steel, pig-iron was used, but after the first cast it had been decided that pig-iron was not a suitable ingredient to form the basis of the charge.

Mr. R. B. Templeton, referring to the use of a high percentage of steel scrap—Mr. Robiette had mentioned 75 per cent. in one instance—suggested that in such circumstances there would be great difficulty in controlling the total-carbon content. He asked what was the loss of carbon in a mix of that composition.

AUTHOR'S REPLY

Mr. Robiette, replying to Mr. Kain's question concerning the type of lining which was described as basic, used in the cylindrical or rocking furnace, said that the lining used was of rammed magnesite. The rammed magnesite was being used with compositions containing high manganese content, which readily attacked linings containing silica; and brick linings of new non-spalling magnesite were being tried out.

Carbon Control

Discussing carbon control when using synthetic charges, consisting chiefly of steel scrap, he said that in those circumstances one must more or less standardise the conditions of adding the carbon in order to secure the same percentage recovery all the time. The carbon was generally placed at the bottom and the steel scrap was placed on top, and the carbon was completely covered, so that there were not variable oxidation losses; it was preferable to cover with light scrap which was not porous—say, borings or punchings. As the metal commenced to melt, it trickled over the material below and sealed up the coke, which was gradually being absorbed throughout the melting period, and when working charges of similar composition and materials, one could hold the carbon recovery, on the average, between 65 and 75 per cent. The scrap must not be excessively oxidised—there must not be too much rust or scale on it—otherwise it would burn the carbon. One could hold the recovery within 72 to 75 per cent. The results were not affected very greatly, when making synthetic iron in that manner, by the amount of silicon added. Generally, the carbon pick-up was not very sensibly above 2.2 per cent., and could be controlled within fairly narrow limits. The metal was usually tested by the breaking of the wedge bar.

Power Consumption and Speed

The question of power consumption for cast-iron melting was largely a matter of time. The losses in the furnace were constant all the time, and if one could melt a quantity of iron in 1 hr. instead of 2 hrs., those losses per charge were halved. So that with rapid-melting furnaces the melting losses per ton were low. It was only in very small furnaces, or furnaces of low power input, that the power consumption was ever more than 650 units per ton—to melt and superheat the metal to about 1,500 deg. C. The 3 per cent. melting loss referred to in the Paper was a very average figure; when melting all borings, the melting loss was not very much in excess of 4 per cent. In the rocking-arc furnaces, where one could seal up the charge almost completely, the loss was not more than 1 per cent.; when using the heaviest scrap, the average figure was from 1 to 2 per cent. Power was available normally at the price of 0.5d. per unit in most industrial localities; Mr. Robiette admitted that it was rather more expensive in the South of England than in the North, but he pointed out that the power companies were gradually becoming alive to the fact that the power used in melting a ton of cast iron was equivalent to that used by 2,000 electric irons in an hour, and they were gradually reducing their prices to secure the industrial loads.

Operating Costs

In melting, assuming a 3-ton furnace operated by one man and a helper, the labour costs were 4s. per ton; electrode costs were quite reasonable, at about 7s. per ton; refractory costs were rather high at the figure of 4s., and he had included 5s. for depreciation and amortisation—15 per cent. on the capital outlay. The melting costs were quoted as £2 7s., and although Mr. Kain had suggested that the figure should be at least twice as much, it was about the figure experienced by users of electric furnaces. There was something wrong if the melting costs were more than £3 per ton.

With regard to the use of cheap pig-iron, he said he had assumed the use of pig-iron containing a slightly increased percentage of phosphorus, and reducing the phosphorus content by adding mild-steel scrap.

The information concerning the maintenance of the hardness figures within 13 points Brinell over a period had come from America, and was obtained by tests on cylinder blocks. He could not say whether or by how much it had been over-stated, but the figure was given to him as having been obtained over a period of three months. The furnace was operated on the continuous cold-melting principle; it held continuously a charge of about 10 tons, there being feeds of about 200 to 300 lbs. at intervals of about 10 min., and pouring was carried out every 10 min. The analysis was checked once per hour or per two hours.

Electric Malleable Heat-Treatment

With regard to malleable, a good deal of the primary treatment was carried out at a temperature as low as 920 deg., but the range was from 920 to 950 deg. The photomicrograph had shown quite an appreciable reduction of grain size, due to the fact that the material was maintained at temperature for a short time only. The malleable irons referred to in the Paper were treated in a tunnel kiln, where they were exposed to temperature for a rather shorter time than in the old type of kiln; the period of exposure to 900 deg. or so in the tunnel kiln was only about 4 hrs.

It was difficult to secure compositions exactly the same from the cupola and the electric furnace, to enable comparisons of density to be made; but if the silicon content varied, the density would naturally be affected. The general impression was that electric-furnace metal gave very much denser castings, and was especially useful for castings which had to withstand very high pressures. There was very much less tendency to breakdown in pressure tests, due, it was said, to the rather close grain and high density of the material.

For Mass Production

Dealing with the Branch-President's question as to the tonnage which might be considered as being outside the range of a jobbing foundry and within the classification of the mass-production foundry, Mr. Robiette said he had considered anything under 10 tons per hr. as being within the sphere of the jobbing foundry; but he based his classification upon the nature of the work that was done rather than upon the output. A fairly high tonnage of 10 tons of castings per hr., the castings being essentially similar, would constitute mass production. For that tonnage, one would require a 2- to 3-ton furnace, if one were duplexing from a cupola.

Conveyor pouring had been applied chiefly to the production of automobile castings—crankshafts, camshafts and cylinder blocks—the metal being poured from the electric furnace at fairly regular intervals of 10 to 15 min. where a continuous system of melting or continuous duplexing was employed. The metal was first poured into a receiver, which was not heated; the receiver had a bottom tap hole, and acted in the same way as a foundry ladle, being fitted with a stopper. The weights of castings made ranged from, say, 30 lbs. to 2 cwts.

The Nitrogen Bogey

Replying to Mr. Faulkner's reference to the differing voltages which had been applied to furnaces, he said that one could not very well increase the power on the furnace to-day (without affecting the electrical characteristics) in any other way than by increasing the voltage; otherwise the trouble of low power factors would arise. The current was more or less limited. It had been said that high-voltage arcs tended to introduce nitrogen, but that was very debatable. If nitrogen were absorbed due to local temperature, the answer was that the temperature of the arc was no different whether the voltage were high or low. The length and the spread of the arc were different; there was a very much greater spread of the arc in a high-voltage furnace, but the metal was melted rather more rapidly than in a low-voltage furnace, so that it was not subjected to the influence of the arc for such a long time as it would be in a low-voltage furnace. An arc voltage of about 110 would melt the metal in about half the time taken with an arc voltage of 60 or 70.

Speed of Roof Change Conserves Refractories

Dealing with Mr. Faulkner's criticism of the top-charging arrangement, that the dumping of a cold charge and the exposure of the refractories as the result of lifting the roof might have a detrimental effect, Mr. Robiette said the charging time was so short that the refractories had little or no time to cool down. The roof was swung off, the charge introduced, and the furnace shut down again in less than about 3 min. There was a reduction of about 33 per cent. in refractory costs per ton of metal, mainly due to the increased output, because instead of the charging time being about 40 min., it was only about 5 to 10 min. altogether. The cost of the electrodes was also reduced, even though they were exposed repeatedly to oxidising conditions. No electric-furnace manufacturer would believe that until it had been tried out, and development had been hindered because electric-furnace manufacturers had thought there was very little advantage in top charging, due to the supposed bad effects on refractories and electrodes.

Mr. Faulkner said he presumed, therefore, that the refractories in the top-charging furnace would give about the same life as those in the ordinary electric furnaces.

Mr. Robiette replied that the refractories would stand up to the work for a certain time, say four weeks; but a greater quantity of metal would be melted during that period when top-charging was adopted than when it was not adopted. With regard to the cooling of the roof, he said that the roof itself was not water-cooled. The ring on the top-charging furnace was water-cooled, to prevent the distortion of that ring which would result in an uneven seating. Sometimes the cheeks of the doors were water-cooled just where they were subjected to the flames issuing from the furnace.

The question by Mr. Templeton, concerning carbon control when making synthetic irons from steel scrap, had been answered by the reply to Mr. Kain, that if the charging of the scrap and the nature of the scrap were the same each time, one could control the carbon to within about 0.1 per cent., by recarburising, up to about 2 per cent. total carbon pick-up.

Vote of Thanks

MR. A. W. G. BAGSHAWE, proposing a vote of thanks to Mr. Robiette for the Paper, commented that possibly Mr. Kain might have seemed remorseless in asking so many questions, but no doubt Mr. Robiette had appreciated the spirit in which they had been asked, and indeed had been gratified; it was most distressing to present a Paper which failed to draw comments or criticisms. This led Mr. Bagshawe to urge that members of the Branch should ask more questions and make more criticisms than they did ordinarily. However, the meeting had thoroughly enjoyed the Paper, and hoped that in the future, when Mr. Robiette had further information to give, he would present another to the Branch.

MR. A. J. MURPHY, seconding, said that a great many had noted with interest the policy of Mr. Robiette's company in introducing to this country the Detroit rocking arc furnace. If the discussion had been rather critical, that was an indication of the very keen desire of foundry people to obtain a real appreciation of the exact advantages and disadvantages of the new process. Mr. Murphy felt sure that most non-ferrous metallurgists shared his view that, so far as the technical merits of the process were concerned, they had long been converted; they knew of the experience in America, and they had knowledge of the technical features of the use of electricity for melting non-ferrous metals. One obstacle was the dislike, on the part of electrical engineers, of unbalanced loads; but he understood that they were overcoming that prejudice to some extent. Other difficulties were the cost of power, certainly in the South of England; and the first cost of the plant, which was an extremely serious obstacle to the small jobbing founder particularly. Technical people, however, wished Mr. Robiette and his company the best of luck in their further developments.

The vote of thanks was carried with acclamation.

MR. ROBIETTE, in his response, assured the meeting that he had appreciated the criticisms made as being a very healthy sign, and joined in expressing the hope that more speakers would raise criticisms, so that he would have ample opportunities of justifying all the claims he made.

THE SHEFFIELD DISCUSSION

Green or Dried Sand for Steel Castings

MR. S. LEETCH said he had listened with great interest to the Paper by Mr. Walker and Mr. Dadswell. He thought that they had made out a very good case for electric steel and seemed to have anticipated a few of the drawbacks that one might mention, and had dealt with them faithfully. His own view about electric steel was that if one could shank it and carry it about the shop as they could Tropenas steel, it would be very convenient. Mr. Dadswell and Mr. Walker had referred a great deal to green sand, and its relative merits should be very carefully considered. Where one had light things, such as bolsters, to deal with, those with whom he was associated used green sand. Where a great deal of machining was to be done on a small casting, it was considered much better to build up the job in oil-sand moulds. One could then be sure of a good sand mould. The question of the steel being satisfactory could, in ninety-nine cases out of a hundred, be left to the steelmaker. One found one or two exceptions occasionally where there were pinholes and blowholes in castings. One might insist that it was the steelmaker's fault, but, generally speaking, a rising heat was a very rare occurrence in any foundry. When faults such as pinholes occurred, he thought they would be due either to the mould not being thoroughly dry, or the oven not being correct. This was something that one must look after oneself. He recognised that a great deal of work could be done on the subject of green sand, but to his mind the question was whether it was going to give the customer the same satisfaction as a casting made in dry-sand moulds. He (Mr. Leetch) was greatly interested in the use of the ⅛-in.-thick chills to which Mr. Dadswell had referred. His own idea of chilling had been the conducting of the heat from the heavier portion of the steel, and thereby the equalising of the cooling and the rate of contraction. He was not quite sure whether the very light chill which Mr. Dadswell advocated would produce a nice clean face in the radius, but that, if one were to saw through a certain point, a distinct cavity might be found.

Life of Electric Steel

MR. WALKER said that he, personally, had not had much experience of Tropenas steel for foundries, and was surprised that Mr. Leetch should be so anxious regarding the use of electric steel for small castings. The firm with which he (Mr. Walker) was associated found no difficulty in making, say, 150 manganese steel links, weighing about 4½ lbs. each, from a single charge, made in a 3-ton electric furnace.

With regard to green-sand and dry-sand practice, the advantage of green-sand moulding was that it was cheaper to produce green-sand castings than dry-sand castings. There was a saving of cost because moulds had not to be dried, but, apart from this, a good deal of time was saved in actual operations in the foundry. Moulds could be made and the castings poured a short time afterwards, so that the boxes could be knocked out and refilled again much more quickly than was possible if the moulds had to be dried.

Advantages of Shanking

MR. DADSWELL agreed with Mr. Walker that they were very successful in making small castings from an electric furnace, but said that there were decided advantages in shanking. For example, shanking was useful for snap-flask work. With a mould made from a bumper squeezer machine in a snap flask without jackets they could not cast anything of, say, 3 lbs. to 4 lbs. with a bottom-pouring ladle, as the metal would burst out at the joints. At his works they were filling shanks from a bottom-poured ladle. They confined themselves to shanking about 25 moulds with each cast of 3 tons brought on the floor for other work. The jar squeezer machine was a useful adjunct to the foundry for making small castings, which one accepted on sufferance sometimes in order to get bigger orders and which were very costly if built up in cores. He agreed that it was inadvisable to cast too many castings off the same runner because it was difficult to get them all sound by that method.

Green-Sand Work Shows Economies

As far as using green or dry sand was concerned, there was a very large saving in using green sand. In regard to external chills, these were useful from two points of view—they prevented cracking and helped soundness. In regard to Mr. Leetch's reference to American green sand, he agreed that their castings were rough, judged from English standards. In fact, English inspectors would not accept them. At the same time, they were often good enough for the job for which they were required. As long as the casting was sound, what did it matter if it were a bit rough when placed, say, underneath a wagon? He believed that one of the reasons for the American castings being rougher was that the Americans cheapened production considerably by reclaiming sand. In many of the mass-production foundries on railway work in America hardly any new sand was used, perhaps 10 per cent. of new sand being used only. In England they used a better-quality sand than the Americans, and consequently made better-finished jobs, but at a greater and unnecessary cost.

Steam and Soundness

MR. E. J. CRAWLEY asked for some explanation relating to the encouragement which steam from green-sand moulds gave to the evolution of carbon monoxide in castings.

MR. WALKER said that green-sand moulds contained water which, on being heated to 100 deg. C., vaporised to form steam. That steam, if sufficiently heated, would dissociate into oxygen and hydrogen, but the percentage of dissociation at the temperatures reached in the moulds would be negligible. If, however, the steam came into contact with liquid steel containing a substantial amount of dissolved gases, a considerable portion of the gases would be evolved. What happened could be compared with the passing of a stream of air into a solution of carbon dioxide in water. Carbon dioxide was very much more soluble in water than air, and the result of passing in the air would be that nearly all the carbon dioxide would come out of solution, leaving behind a saturated solution of air containing much less dissolved gas. If afterwards a stream of carbon monoxide, which was practically insoluble in water, was passed into the air solution, the air in turn would be driven out and at the end there would be very little gas left in solution in the water on account of the very low solubility of the carbon monoxide. In the same way, steam passing through liquid steel which was saturated with gases would have a mechanical effect resulting in the evolution of some of the gases as such.

Metal Handling

MR. J. ROXBURGH said Mr. Walker had shown them the head of a casting that had a skin of high carbon, and stated that it was due to the absorption of the facing which had been used on the green-sand mould. He wondered whether it was possible in the steel foundries to cast into green-sand moulds without using blacking. Then Mr. Walker had referred to the fact that they were casting a great number of castings from a 3-ton ladle. He wondered if it would not be possible to divide the metal in the first place into three separate ton ladles, and thus get rid of it in a much quicker time. He would also like to know what Mr. Dadswell would say was the largest section of casting that he had made in green sand.

Why One Ladle is Used

MR. WALKER said that no blacking had been put on the green-sand moulds at all. He had shown slides illustrating the effect of surface-blacking on a mould merely as an item of interest. Regarding the suggestion that a 3-ton charge could be poured into a ladle at intervals and used in separate portions, he explained that when the furnace was tapped, the steel was run into the ladle until all the steel came out and was covered by a layer of slag. This slag served a very useful purpose in keeping the steel hot. If a portion of the charge was run out instead, it would have no protective covering of slag and would cool down very rapidly when it was taken into the foundry.

The Largest Green-Sand Casting

MR. DADSWELL, dealing with Mr. Roxburgh's question relating to the largest section of casting made in green sand, said they had made one of 15 cwts. in weight, and about 1 in. thick. Large flat surfaces in green sand were not so easy to obtain satisfactorily.

MR. LEETCH said that at his works they made 2-ft. 9-in. wagon centres in green sand.

The authors of the Paper were accorded a vote of thanks, on the proposition of MR. LEETCH, seconded by MR. ROXBURGH.

A NEW FURNACE of 80 tons capacity at Richard Thomas & Company's South Wales steelworks, Llanelly, has been completed. Its lighting will bring the number of furnaces in operation at the works to seven.

The supplying of vitreous acid resisting enamels is a problem which has been tackled by our experts, who have studied the difficulties incurred by the usage of these enamels and have reduced them to a minimum.

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Leaves from a Foundryman's Notebook

IX.—PATTERN ALLOWANCES

By "RECORDER"

The subject of the following notes is one that is very important in the construction of patterns for repetition or even semi-repetition work, as the neglect of one or more of the following considerations may result in increased work in the foundry, which, although occupying only minutes each time, accounts for hours in the course of a year. Every foundryman is familiar with the allowance left on patterns for the contraction of the casting on cooling, and the number of patternmakers who ban the use of the contraction rule is growing smaller.

There are still, however, many patternmakers who follow the contraction rule implicitly, and who never depart a hairbreadth from it. It is for their benefit that the following experiences are recorded, for these men may in most instances be working in shops which supply patterns to the trade and never have an opportunity of witnessing the moulding and assembling of the cores made from their patterns and coreboxes. Such a set of conditions is far from ideal, for it is only as the patternmaker watches the results of his labours that he learns some of the more important lessons of his craft.

One of the greatest pleasures that can be afforded a moulder on the moulding floor is to get a complicated job in which all the cores fit together without the necessity to rub off various amounts from different places of his cores to allow of their being inserted in their respective positions in the mould. Such a state reveals that the patternmaker who constructed the pattern and coreboxes knew just when and where to make "pattern allowances." On the other hand, nothing is more annoying than, after having assembled a number of cores, to find that one or more have to be removed and have an amount rubbed off to make a space for the thickness of metal in the mould.

Such things frequently happen, and when the pattern and coreboxes are collected to be checked over it has been found that they measure up perfectly by contraction rule. What then is the trouble, and how is it that the mould and cores produced from these correctly-measuring patterns and coreboxes do not fit?

There are a number of factors at work which a patternmaker who has had no experience in foundry work fails to appreciate. There are no hard and fast rules which can be laid down as to the various amounts of "pattern allowance," as it will be found that foundry methods vary from place to place and the best results can only be obtained by a systematic checking of patterns and recording the results obtained in the foundry.

An Example from a Bed Frame

Fig. 1 is a sectional elevation of a bed frame for a high-speed engine and illustrates the tendency for cores to "grow." On assembling the cores of a casting such as this—in which the majority of the cores were all made in one large corebox suitably partitioned—it was found many years ago, when the first of this type was made in a certain foundry, that the last core to be placed in the mould left no thickness between it and the mould.

As usual in these cases the patternmaker was blamed, yet on checking over the corebox it was found to be correct by contraction rule. The explanation was that each of the cores that composed the interior of this bed frame was made on a cast-iron grid, which on the drying of the core expanded, thus making the core just slightly larger, but which, on cooling down, before insertion in the mould, failed to contract and was thus bigger than its corebox. Although each core was only slightly larger than required,

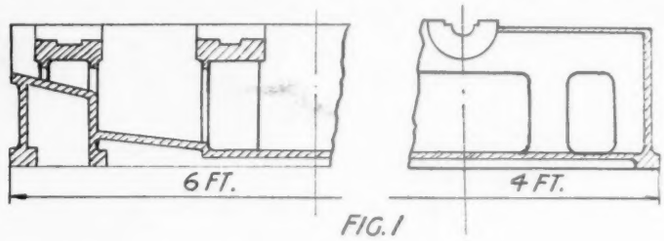

FIG. 1

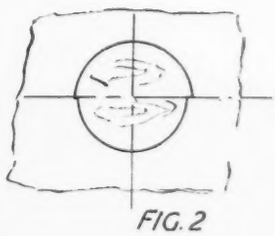
FIG. 2

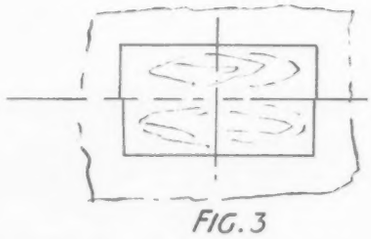
FIG. 3

the total of these increments on each of the sections was enough to rob the casing of its thickness at one end.

This corebox was then "corrected" by making it smaller than required, and if a novice measured it by contraction rule he would think that it was wrong, but this is a case where a corebox must be made "wrongly" to get the casting correct with the minimum of trouble. Not only large castings carrying a number of cores exhibit this feature, but also smaller jobs where there are a number of complicated cores, and great care has to be exercised to ensure of the mould giving the required $\frac{1}{4}$ in. or $\frac{5}{16}$ in. thickness as called for on the blue-print.

Then again an allowance which could be more often made by the patternmaker is to make the coreprints slightly on the big side so that the core can be inserted in the mould without destroying portions of the print impression and so carrying dirt into the mould, which has subsequently to be cleaned out. Especially is this important on the top halves of moulds as invariably if not done on the pattern the moulder eases the prints to avoid a "crush."

Fig. 2 shows an end view of a job jointed in halves, the prints on the top half of which are made on the full side. Fig. 3 is a similar illustration of a rectangular print. The allowances that should be made on a pattern to obviate distorted castings due to contraction are too many to be considered in these brief notes, and may be considered later. Meanwhile, as a generalisation, the patternmaker should make an allowance for cores "growing" although the amount varies from place to place with the sand mixtures used, the drying of the core and the type of mould in which it is to be used. Moreover, clearance should be made on coreprints for dry-sand work, and for small work carrying a number of cores giving a thin metal section an allowance for the coating of black wash will be found to be advisable.

Phœnix Tube Works Curtailment

STEWARTS AND LLOYDS' DECISION

Stewarts and Lloyds, Limited, will cease major operations at the Phœnix Works, Rutherglen.

An official announcement states:—"The restriction in force on the import of Continental Bessemer steel makes it economically impossible to continue the present state of manufacture, particularly when the bulk of production must be sold against world competition on the export market. A further contributory cause is that Australia is now practically self-sufficient in tube manufacture. Over 30 per cent. of the output of the Rutherglen works was shipped to this market, and the permanent loss of this tonnage must be faced."

A further statement issued by Stewarts and Lloyds says that the announcement of their decision to close their Phœnix Works has given rise in some quarters to the impression that the company is not in complete accord with the policy pursued over the last four years by the British Iron and Steel Federation, with the support of the Import Duties Advisory Committee and the Government, to develop the production of iron and steel in this country to the maximum possible extent. This is incorrect. Much as the company regrets the necessity for closing the works, the decision has been forced upon them by the growing intensity of world competition in tube manufacture in recent years. In order to meet this competition the company has erected an entirely new works on their ore field at Corby, where they are now producing steel tubes and other products under the most advantageous conditions and with the most efficient modern plant. This development, which has been greatly helped by the resolute tariff policy of this country, has already led to a material increase in national employment, resulting not merely from the growth of the company's export trade, but still more from the manufacture in this country of basic-Bessemer steel, formerly obtainable only from the Continent.

Phœnix Works is not geographically suited to be supplied with its raw material from the new works, and it has therefore been found necessary to concentrate the manufacture of the bulk of the tubes formerly made in these works at Corby. The balance will be transferred to other works of the company in Scotland.

The company has endeavoured to minimise the disturbance to local employment by the transfer of as many workpeople as possible.

Glenboig Union Fire-Clay Company

General Refractories, Limited, of Sheffield, have made an offer for the purchase or exchange of shares in the Glenboig Union Fire-Clay Company, Limited. The offer is £9 in cash for each £10 share of Glenboig, or eight 10s. ordinary fully-paid General Refractories shares. These will rank for dividend as from January 1. The directors of the Glenboig Company recommend acceptance of the offer in one or other of its forms. The offer is contingent on its acceptance by holders of at least 51 per cent. of the Glenboig share capital, but the right is reserved to accept a smaller percentage. The directors of General Refractories, Limited, state that they are in a position to arrange for the provision of the funds which they consider necessary for the modernisation and re-equipment of Glenboig works

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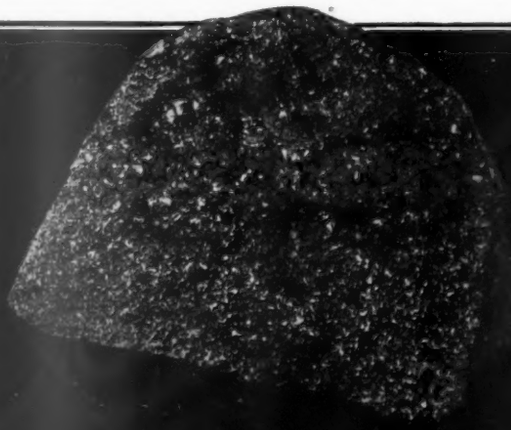

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PIG IRON

This Week's News in Brief

Trade Talk

THE BIRMINGHAM BRANCH of the Institute of British Foundrymen have postponed their Annual Dinner until March 28.

THE SOUTH STAFFORDSHIRE IRONMASTERS' ASSOCIATION has altered the date of the Birmingham quarterly meeting from April 9 to April 2.

MACKENZIE & MONCUR, LIMITED, of Edinburgh, have booked an order for 227 superheater headers for the London Midland & Scottish Railway Company.

LITHGOWS, LIMITED, Port Glasgow, have booked orders for a 9,000-ton oil-carrying steamer and an 8,000-ton general cargo steamer, both for British owners.

THE CUNARD WHITE STAR LINE have disposed of their liner "Homeric" for demolition purposes. The purchasers are Thos. W. Ward, Limited, Sheffield.

A PARTY OF MEMBERS of the National Association of Schoolmasters recently paid a visit to the Midland Foundry, at Sandiacre, of Taylor Bros. (Sandiacre), Limited.

EMPLOYEES OF THE Castlecary and Bonnybridge works of John G. Stein & Company, Limited, held their 17th annual dance last week. Colonel Alan Stein presided.

THE SOUTH AFRICAN RAILWAYS AND HARBOURS ADMINISTRATION have placed orders with Lobnitz & Company, Limited, Renfrew, for the construction of a suction dredger and two powerful tugs for use in South Africa.

ORDERS FOR THE propelling machinery, consisting of two sets of steam reciprocating engines, for an oil-carrying vessel and a cargo steamer being built at Port Glasgow have been placed with Messrs. Rankin & Blackmore, Limited, Greenock.

THE ISLE OF MAN STEAM PACKET COMPANY, LIMITED, have placed an order with Vickers Armstrongs, Limited, of Barrow-in-Furness, for two geared turbine steamers which are to have a length of 326 ft., a breadth of 47 ft., a moulded depth of 18 ft., and a speed of 21 knots.

SHORT BROS., LIMITED, Sunderland, who recently launched the last ship on their building stocks, have secured orders for three single-deck cargo steamers for the Springwell Shipping Company, Limited, London. The triple-expansion propelling machinery will be supplied by the North-Eastern Marine Engineering Company, Limited, Sunderland.

THE SOCIETY FOR THE PRESERVATION OF SHEFFIELD TOOLS hopes to make an industrial museum at Abbeydale, Sheffield, in which will be shown four water-wheels with their old gearing, a crucible-steel-melting shop with complete equipment, a set of tools for making chains by hand, and one of the first rolling mills ever used for iron or steel. It is stated that this exhibit was either the first or second rolling mill ever made.

THE TOTAL SOVIET PURCHASES in Great Britain during the year 1935 amounted to £9,977,600, of which £2,118,900 was in respect of machinery and equipment. The purchases included :—Machine tools, £432,000 (£653,700 in 1934); electric power equipment, £12,400 (£26,000); mining equipment, £10,600 (£43,900); metallurgical equipment, £41,600 (£22,200); ships, £575,300 (£187,500); ships' equipment, £21,700 (£3,700); locomotive and transport equipment, £391,000 (£7,500); pumps and compressors, £30,900 (£71,700); presses and hammers, £34,400 (£46,800).

AN ORDER has been made by the Irish Free State Executive Council imposing a new duty of 40 per cent. *ad valorem* on the following manufactured articles of cast iron:—Fire grates, ranges, stoves (other than stoves primarily adapted for use in heating water in connection with hot-water circulating systems), mantel registers, domestic hollow-ware, etc. The duty will not apply to fire grates, ranges, and stoves which can be heated by electricity, gas or oil. The Order also provides that the existing duty of 25 per cent., applicable to a number of cast-iron manufactures, is to be increased to 40 per cent. *ad valorem*. An open licensing provision provides for free importation of articles affected that at the moment cannot be supplied from home sources. Arrangements have been made for the establishment of a factory at Waterford to manufacture various articles of cast iron. This factory is to be known as Allied Ironworks (Ireland), Limited, and will have an authorised capital of £100,000. English associates are taking up half the issue, and the two English directors are Mr. J. I. Chesshire (of Izons & Company, Limited, West Bromwich) and Mr. T. O. Lander (a director of Allied Ironfounders, Limited). These companies are to undertake the technical supervision for five years. The new works are to be situated on the banks of the River Suir, a site possessing rail- and sea-borne traffic facilities. English workers may be sent over from West Bromwich.

Personal

MR. E. J. KELLY has changed his address from 26, Union Street, Pontypridd, to Clwyd, Cardiff Road, Hawthorn, near Pontypridd.

COUNCILLOR A. TURNER, a director of Foundry & Engineering Company (West Bromwich), Limited, Sandwell Road, is to be chairman of the West Bromwich and District Manufacturers' Association as from next Wednesday.

MR. WILLIAM REID, general manager of Davy Bros., Limited, of Sheffield, the well-known manufacturers of steelworks plant and forging machinery, has just returned from a visit to the United States, where he has been inspecting the latest types of four-high continuous rolling mills in use in that country. Mr. Reid has been making arrangements to manufacture certain types of plant in this country to the latest American designs—a matter of some interest to British steelmakers.

SIR JOHN HUNTER has resigned the chairmanship of Sir William Arrol & Company, Limited, after 50 years' service, but will remain an advisory director. During his association with the company it has constructed the Tay Bridge, the Forth Bridge, the Tower Bridge, London, and many bridges in other parts of Great Britain and the Colonies. Sir John was director of factory construction and steel production of the Government during the war. The new chairman is Mr. Henry Cunningham.

Wills

DAGLISH, R. S., of Robert Daglish & Company, Limited, engineers and boilermakers, of St. Helens Foundry, Foundry Street, St. Helens £52,476

HICKMAN, VICTOR, of Tettenhall, Staffs, late a director of Alfred Hickman, now a branch of Stewarts and Lloyds, Limited, and a director of the Haunchwood Collieries, Limited, Nuneaton £211,568

Obituary

MR. JOHN HASTINGS, who was for 62 years in the employment of the Falkirk Iron Company, Limited, has died at the age of 87 years.

MR. CHARLES HENRY WALLWORK, chairman of Henry Wallwork & Company, Limited, ironfounders and engineers, of Redbank, Manchester, died recently. He was in his 82nd year.

THE DEATH HAS OCCURRED of Mr. J. L. Rushton, J.P., managing director of Dobson & Barlow, Limited, textile engineers and ironfounders, of Kay Street Works, Bolton. He was for many years a leading personality in the textile-engineering industry, and when the firm was merged into Textile Machinery Makers, Limited, a few years ago, he became a director of that company. He was 64 years of age.

New Company

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Fisher & Eglin, Limited, Market Weighton, Yorks.—Capital, £1,000. Ironfounders, etc. Directors: W. L. Fisher, H. K. Eglin and Mrs. M. Fisher.

Company Reports

International Nickel Company of Canada, Limited.—Usual quarterly payment of $1.75 on the preference stock.

W. Canning & Company, Limited.—Final dividend of 5 per cent. and a bonus of 12½ per cent., making a total distribution of 22½ per cent. for 1935.

Brown Bayley's Steelworks, Limited.—Payment of one year's dividend on the 5 per cent. preference shares, discharging arrears to July 31, 1933.

Radiation, Limited.—Final payment for 1935 on the ordinary shares of £9 7s. 6d. per cent. (making 12½ per cent. for the year) and a bonus of 2½ per cent., both less tax.

James Booth & Company (1915), Limited.—Net profit, after providing for depreciation, income tax, and directors' fees, £67,285; brought in, £20,877; preference dividend for year, £8,680; dividend of 15 per cent. on the ordinary shares, £29,062; to reserve, £20,000; staff fund, £5,000; carried forward, £25,420. Additional capital being required for repayment of the debentures of the subsidiary company, and for forthcoming expenditure on extensions to buildings and plant, the directors propose to offer to ordinary shareholders at a premium of £1 per share one new ordinary share for every five shares held.

Colvilles, Limited.—Trading profit for the year, including revenue from properties, and after making full provision for bad and doubtful debts and all charges, £610,708; brought in, £85,762; depreciation and obsolescence of fixed assets, £125,000; income tax, £120,000; dividend on the 5½ per cent. cumulative preference shares for the year ended September 30, 1935, £85,250; provision for preference dividend for three months to December 31, 1935, £21,312; to special reserve for preference dividend, £200,000; staff superannuation fund, £20,000; carried forward, £124,908. The directors do not recommend a dividend on the ordinary shares.

Forthcoming Events

MARCH 13.

Institute of Welding (Midlands Branch):—"Influence of Welding on Design," Paper by S. E. Evans, at the James Watt Memorial Institute, Newball Street, Birmingham, 3, at 7.15 p.m.

MARCH 14.

Keighley Association of Engineers:—Annual Dinner, at the Queen's Hotel, Keighley; Reception at 5.45 p.m.

MARCH 17.

Institute of Welding (North-Eastern Branch):—"Welding in the Engineering Industry," Paper by J. A. Dorrat, at the Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 7 p.m.

MARCH 18.

Institute of Welding (London Branch):—"Heavy Machinery and Marine Engineering," Review by H. N. Pemberton, at the Institute of Mechanical Engineers, Storey's Gate, London, S.W.1, at 6.30 p.m.

Manchester Association of Engineers:—"Materials and Maintenance of Lifting Gear," Paper by E. W. Colbeck, at the Engineers' Club, Albert Square, Manchester, at 7.15 p.m.

Institute of Metals

MARCH 13.

Sheffield Local Section:—Annual General Meeting, in the Non-Ferrous Section of the Applied Science Department of the University, St. George's Square, at 7.30 p.m.

MARCH 17.

Birmingham Local Section:—"Recent Developments in Metallurgy," Paper by Prof. D. Hanson, at the James Watt Memorial Institute, Birmingham, at 7 p.m.

Swansea Local Section:—Annual General Meeting; "Metallurgical Control and the Bronze Foundry," Paper by A. J. Murphy, at the Y.M.C.A., Swansea, at 6.30 p.m.

Institute of British Foundrymen

MARCH 14.

Scottish Branch:—Annual General Meeting; presentation of "John Surtees" prizes; "Castings," Paper by W. Machin and M. C. Oldham, at the Royal Technical College, George Street, Glasgow, at 4 p.m.

West Riding of Yorkshire Branch:—Works visit to William Asquith, Limited, Halifax.

MARCH 17.

Newcastle-upon-Tyne Branch:—"Foundry Costs," Paper by S. G. Homfray and R. A. Balderston, at Neville Hall, Westgate Road, Newcastle, at 6.15 p.m. (joint meeting with Institute of Metals).

MARCH 20.

Middlesbrough Branch:—"Some Aspects of Coke Making," Paper by W. Scholes, at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

MARCH 21.

Wales and Monmouth Branch:—Annual General Meeting, at University College, Newport Road, Cardiff, at 6.30 p.m.

SAND MIXING AND HANDLING

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Engineering Skill and Foundry Technique have, during the past year or two, displayed a remarkable desire to marry for the benefit of the Foundry Industry.

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This announcement will, we hope, remind you that we are well able and desirous of placing proposals for Modern Foundry Equipment before you.

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Raw Material Markets

Most of the iron and steel works have sold their outputs for a considerable time ahead, and plants are employed on full time. In some areas deliveries are behind schedule, and prices are likely to rise still further following the increased costs of production. As a result new business is not being arranged to any great extent. Consumption of iron and steel is heavy. Inquiries from abroad have shown an expansion.

Pig-Iron

MIDDLESBROUGH.—A further increase in output has been made in this area during the past week, but the supply position continues to be stringent, and new business is out of the question as far as makers in the Cleveland district are concerned. Deliveries are belated in many cases. It is reported that another furnace is to be put into operation on the manufacture of foundry iron in the near future. Present fixed minimum prices, which are based on No. 3 Cleveland G.M.B. at 70s. delivered Middlesbrough or Falkirk, are likely to be raised later in the year.

Business in East Coast hematite has been restricted following the increase in quotations. Official ratification has not yet been given to the new minimum of 77s. per ton for No. 1 hematite, delivered Middlesbrough, North-East Coast or Scotland, and there is still some doubt as to whether this will be given or not. However, as soon as this question is cleared up it is expected that the demand will be even heavier than before. Many makers are reluctant to quote for export inquiries, their outputs being well sold on home account.

LANCASHIRE.—Only a moderate amount of business has been transacted in the pig-iron market recently, but the demand is expected to increase following the expiration of a number of contracts in the near future. Deliveries into consumption remain quite satisfactory, a large tonnage being taken up. Offers of Derbyshire, Staffordshire, and Lancashire brands of No. 3 foundry iron for delivery to consumers in the Lancashire price zone are all on the basis of 78s. per ton up to June 30 and 83s. for deliveries after that date, with Northants at 76s. 6d. and 81s. 6d., respectively. Scottish No. 3 is quoted at around 87s. 6d., West Coast hematite at 85s. 6d., and East Coast hematite at from 84s. 6d. to 85s., all delivered equal to Manchester.

MIDLANDS.—Several furnaces in this area are out of the market either for prompt or forward deliveries of pig-iron, but there are others who are willing to contract at the minimum zone rates for deliveries before the end of June, with a premium of 5s. for deliveries after that period. Current Association quotations are 72s. 6d. for Northants No. 3 and 75s. for Derbyshire, Lincolnshire and North Staffordshire No. 3, delivered Birmingham and Black Country stations. An additional 11d. per ton is charged for delivery into consumers' works. A small sliding-scale rebate is allowed to large users. Prices of special irons are firmly maintained, medium-phosphorus irons being quoted at from 80s. to 87s. 6d., low-phosphorus from 92s. 6d. to 100s., and refined iron for special work at £6 10s. to £7 15s., delivered this district. Many consumers report that it is difficult to secure supplies of some grades of hematite iron. Makers are not anxious to obtain new business, and in some cases inquiries are being refused. Current prices are £4 7s. 6d. for East Coast No. 3, £4 8s. 6d. for West Coast mixed numbers, and £4 7s. for Welsh mixed numbers, delivered Birmingham and Black Country stations in 10-ton lots, with 1s. 6d. per ton extra for delivery into works.

SCOTLAND.—Firm conditions continue to prevail in the Scottish pig-iron market. A good demand is being experienced, and supplies of some grades are scarce. It is hoped that the output will be increased in a few weeks' time, but the small supplies of fuel available make it difficult to carry this out. No. 3 foundry is still quoted at 74s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. Deliveries of Middlesbrough iron are difficult to obtain, and this is restricting the activity among the light-castings founders. No. 3 Cleveland iron continues to be quoted at 70s. f.o.t. Falkirk and 73s. f.o.t. Glasgow. Midland foundry iron is quoted at 1s. 3d. below the foregoing figures. Active conditions prevail at the steelworks, and basic iron is in specially heavy call. Owing to the uncertainty regarding higher prices new business is limited. The price of 77s. f.o.t. steelworks remains in force for mixed numbers of East Coast, West Coast and Scottish hematite, while basic, British and Indian, is at 70s. (less 5s. rebate) f.o.t. steelworks.

Coke

Most consumers of foundry coke have agreed to pay 1s. 6d. per ton on contracts from January 1; this represents a voluntary increase in reply to the manufacturers' suggestion. Collieries are receiving a heavy demand for supplies. Current prices remain unaltered, and for delivery to Birmingham and district best Durham coke is quoted at from 41s. 6d. to 43s., and Welsh coke from 38s. 6d. (the cheapest) up to 50s. per ton.

Steel

Busy conditions continue to rule in the steel market, and if there has been less new business placed of late, it is principally due to the difficulties which the producers find in accepting orders for near delivery, says the official report of the London Iron and Steel Exchange. Many of the steelworks have booked sufficient contracts to keep them working at capacity for some months to come. In the semi-finished steel market, in spite of the increase in the quantities imported from the Continent, a serious shortage prevails. The production at most of the works making this description of steel is booked for some months to come, and consumers experience considerable difficulty in placing business for near delivery. The slight lull which was noticeable recently in the demand for finished-steel materials has passed, and the requirements of the consuming trades appear to be growing. Practically all the British steelworks can see their way to maintain the present rate of employment for some months to come, and many of them are finding it difficult to keep their deliveries abreast of consumers' needs.

Scrap

Supplies of iron and steel scrap continue to be imported into the Cleveland area from other districts and from abroad. Several local works have covered their requirements for the immediate future, and pressure for supplies is less insistent. Prices remain firm. Good heavy melting steel has a heavy demand at 57s. 6d. per ton delivered works, while machinery cast-iron scrap has been sold at up to 65s.; however, 63s. 6d. is more in accordance with most users' ideas. Good, heavy, foundry cast iron ranges from 60s. to 62s. 6d. Values of all qualities of scrap material are firm on the Midlands market, and the demand is well maintained. Heavy machinery in handy sizes is at 62s. 6d. to 65s., good heavy at 55s. to 57s. 6d., and clean light at 52s. 6d. Short, heavy, steel scrap, as used in the foundries, is at 65s. per ton, delivered works. There has been no abatement in the active conditions which have prevailed on the Scottish market for some considerable time. Heavy steel melting scrap remains at 57s. 6d., with heavy basic or heavy iron and steel scrap mixed, 5s. per ton less. A good demand exists for heavy machinery cast-iron scrap, and the price is firm around 70s. (for pieces not exceeding 1 cwt.). Ordinary cast-iron scrap, to the same specification, is at 65s. to 66s. per ton, delivered f.o.t. consumers' works.

Metals

Copper.—The industrial demand has only been on a moderate scale, and the market as a whole has been quiet. However, the undertone remains satisfactory, and it is expected that the market will benefit from the Government's defence programme. Prices have become firmer during the week. Little business has been transacted in the United States, where the question of prices remains in abeyance. February domestic sales totalled 77,500 tons.

Daily market prices :—

Cash.—Thursday, £35 17s. 6d. to £35 18s. 9d.; Friday, £36 2s. 6d. to £36 3s. 9d.; Monday, £36 5s. to £36 6s. 3d.; Tuesday, £36 5s. to £36 6s. 3d.; Wednesday, £36 2s. 6d. to £36 3s. 9d.

Three Months.—Thursday, £36 5s. to £36 6s. 3d.; Friday, £36 10s. to £36 11s. 3d.; Monday, £36 12s. 6d. to £36 13s. 9d.; Tuesday, £36 12s. 6d. to £36 13s. 9d.; Wednesday £36 10s. to £36 11s. 3d.

Tin.—Firm conditions have prevailed in this market during the past week, and values have remained steady. The Dutch metal authority, Mr. P. Hövig, writing in the current issue of the "Economisch Statistische Berichten," states that experience has shown that visible tin supplies should not fall below 15 per cent. of the world annual consumption, equalling some 24,000 tons at the present level of consumption. He expects that stocks will be raised to that point by the middle of this year.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £214 5s. to £214 15s.; Friday, £213 10s. to £214; Monday, £214 to £215; Tuesday, £214 15s. to £215; Wednesday, £214 to £214 15s.

Three Months.—Thursday, £204 15s. to £205; Friday, £204 10s. to £204 15s.; Monday, £204 15s. to £204 17s. 6d.; Tuesday, £205 to £205 5s.; Wednesday, £204 15s. to £205.

Spelter.—A good demand has been experienced for supplies of this metal recently. Something of a boom is expected in this market directly the armament programmes are commenced. Meanwhile, the chief topic of discussion continues to be the negotiations in connection with the revival of the International Zinc Cartel. It is reported that negotiations between the various groups concerned are well advanced, and that a world conference will probably be held in London in the near future. Communication between members of the old cartel, which collapsed at the end of 1934, has never actually ceased, and various attempts towards setting up the cartel again were made in the early weeks of last year. These attempts were checked, however. Since the annual meeting of the Imperial Smelting Corporation in November last negotiations have been revived again, and there now appears to be every likelihood of a revival of the cartel. This, it is believed, would be very beneficial to the market.

Official quotations were as follow :—

Ordinary.—Thursday, £16 2s. 6d.; Friday, £16 2s. 6d.; Monday, £16 2s. 6d.; Tuesday, £16 2s. 6d.; Wednesday, £16 1s. 3d.

Lead.—It is rather difficult to judge the prospects of this metal, but the armaments programme is likely to stimulate business considerably. A rather increased demand has been experienced in the United States, where values have remained steady.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £16 11s. 3d.; Friday, £16 11s. 3d.; Monday, £16 11s. 3d.; Tuesday, £16 13s. 9d.; Wednesday, £16 13s. 9d.

Contracts Open

Norwich, March 21.—Cast-iron gully grates and frames, for the County Council. Mr. S. H. Warren, county surveyor, Stracey Road, Norwich.

Carlisle, March 16.—Lead pipe, cast-iron goods, malleable iron fittings, for the Gasworks. The Gas Engineer, Gasworks, Rome Street, Carlisle.

Egypt, March 25.—Large cast-iron sealed sewage and gravitation mains, for the Egyption Ministry of Public Works. The Department of Overseas Trade. (Reference T.Y. 5,747.)

Chishill, March 17.—43 tons of 4-in. and 3-in. dia. cast-iron pipes and specials, for the South Cambridgeshire Rural District Council. Messrs. Sands & Walker, Milton Chambers, Nottingham. (Fee £2 2s., returnable.)

Belfast, April 3.—Steam boiler plant with auxiliaries, pipework, feed pump and coal-handling plant, for the Town Council. Mr. F. H. Whysall, city electrical engineer, East Bridge Street, Belfast. (Fee £5 5s., returnable.)

Dundee, March 19.—Two 3-ton, or, alternatively, one 3-ton and one 5-ton electric travelling jib cranes of portal type, for the Harbour Trust. Mr. J. Hannay Thompson, general manager and engineer, Harbour Trust, Harbour Chambers, Dundee.

Merthyr Tydfil, March 16.—1,070 lin. yds. of 12-in. dia. and 245 lin. yds. of 6-in. dia. sand-spun cast-iron pipes with flexible joints, for the Merthyr Tydfil and Aberdare Joint Farms Management Committee. Mr. A. J. Marshall, engineer, Town Hall, Merthyr Tydfil.

CROSSING THE BORDER

and the penalty

YOU see there are many good Iron Founders in the Midlands, and in the South for that matter, who have a secret yearning to mould again with a genuine Scottish Rock Sand, such as perhaps they have once been used to. They like the heavy bond, the coarse grains, the high permeability . . . Others have never known such luxuries.

The trouble comes from not being able to move large chunks of mother-earth down South from the banks and braes without the penalty of spending a lot of money—a deplorable thought !

But the merrily tapping of wayside rocks with our little geological hammers and our love of digging holes have taken effect. We've discovered nature's bounty in a natural rock moulding sand within easy reach of *the Midlands*. (EUREKA !)

It is christened Tor Rock Sand, and we baptize it with just enough water in a painstaking mill to give a wonderfully plastic, coarse, cohesive sand—a moulder's delight.

The scientific fellows say it's like this :—

CHEMICAL ANALYSIS.

Silica	86·8 %
Ferric Oxide	1·43%
Alumina	7·6 %
Lime	·22%
Magnesia	·18%
Titanic Oxide	·18%
Alkalies	1·8 %
Loss on ignition	1·6 %

MECHANICAL ANALYSIS.

Very Coarse Sand (+ 1 mm) ..	16·5%
Coarse Sand (+·5 mm − 1 mm) ..	16·0%
Medium Sand (+ ·25 mm − ·5 mm)	11·0%
Fine Sand (+ ·1 mm − ·25 mm) ..	30·0%
Silt Grade (+ ·01 mm − ·1 mm) ..	7·0%
Clay Grade (− ·01 mm)	19·5%

which doesn't explain everything, but we will if you will write to us.

GENERAL REFRACTORIES

LIMITED

Genefax House, Sheffield

Telephone: Sheffield 31113 (6 lines).
Telegrams: "Genefax, Sheffield."

LONDON OFFICE:
Russell House, Adelphi, W.C.2.
Telephone: Temple Bar 7361.
Telegrams: "Genefax, Rand-London."

SCOTTISH OFFICE:
156, St. Vincent Street, Glasgow.
Telephone: 3250.
Telegrams: "Genefax, Glasgow."

SOUTH WALES OFFICE:
11, Wind Street Swansea.
Telephone: 3680.
Telegrams: "Genefax, Swansea."

and Branch Offices, Works and Agencies throughout the world.

RAW MATERIALS—PRICE LIST

(Wednesday, March 11, 1936)

COPPER

	£	s.	d.
Standard cash	36	2	6
Three months	36	10	0
Electrolytic	40	5	0
Tough	39	0	0
Best selected	39	10	0
Sheets	68	0	0
India	50	10	0
Wire bars	40	15	0
Ingot bars	40	15	0
H.C. wire rods	44	7	6
Off. av. cash, Feb.	35	7	0
Do., 3 mths., Feb.	35	14	3¾
Do., Sttlmnt., Feb.	35	7	0
Do., Electro, Feb.	39	14	0
Do., B.S., Feb.	39	2	6
Do., wire bars, Feb.	39	18	9
Solid drawn tubes			10½d.
Brazed tubes			10½d.
Wire			6½d.

BRASS

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	8d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN

	£	s.	d.
Standard cash	214	0	0
Three months	204	15	0
English	214	0	0
Bars	215	10	0
Straits	215	10	0
Australian	214	0	0
Eastern	219	10	0
Banca	214	10	0
Off. av. cash, Feb.	207	5	2½
Do., 3 mths., Feb.	200	7	9
Do., Sttlmt., Feb.	207	5	3

SPELTER

	£	s.	d.
Ordinary	16	1	3
Remelted	14	0	0
Hard	12	10	0
Electro 99.9	18	5	0
English	17	2	6
India	13	15	0
Zinc dust	19	10	0
Zinc ashes	4	5	0
Off. aver., Feb.	15	5	1⅞
Aver. spot, Feb.	15	2	6

LEAD

	£	s.	d.
Soft foreign ppt.	16	13	9
Empire (nom.)	17	8	9
English	18	15	0
Off. average, Feb.	16	1	7½
Average spot, Feb.	16	0	5¼

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	5	0
Do., V.M. ex-whse.	25	10	0
Rods	28	5	0

ANTIMONY

	£	s.	d.		£	s.	d.
English	72	0	0	to	73	0	0
Chinese, ex-whse.					61	0	0
Crude, c.i.f.					30	10	0

QUICKSILVER

	£	s.	d.		£	s.	d.
Quicksilver	12	5	0	to	12	17	6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 0 0 to £22 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	33 0 0
4/6% car.	21 15 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	33 10 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/5 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£11 5 0 to 11 15 0
76/80% packed	£12 5 0 to 12 15 0
76/80% export	(nom.) £10 5 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	5	0	to	3	6	6
Mixed iron and steel					3	0	0
Heavy cast iron	2	17	6	to	3	0	0
Good machinery	3	2	6	to	3	5	0
Cleveland—							
Heavy steel					2	17	6
Steel turnings					2	0	0
Heavy cast iron	3	0	0	to	3	2	6
Heavy machinery					3	3	6
Midlands—							
Light cast-iron scrap					2	12	6
Heavy wrought iron	3	7	6	to	3	12	6
Steel turnings					2	2	6
Scotland—							
Heavy steel					2	17	6
Ordinary cast iron	3	5	0	to	3	6	0
Engineers' turnings					2	2	6
Cast-iron borings	1	17	6	to	2	0	0
Wrot-iron piling	3	8	9	to	3	10	0
Heavy machinery					3	10	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	29	0	0
Brass	19	10	0
Lead (less usual draft)	14	10	0
Tea lead	10	10	0
Zinc	8	10	0
New aluminium cuttings	74	0	0
Braziery copper	27	0	0
Gunmetal	27	0	0
Hollow pewter	155	0	0
Shaped black pewter	120	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	72/6
,, No. 3	70/-
,, at Falkirk	70/-
,, at Glasgow	73/-
,, No. 4	69/-
Forge No. 4	69/-
Hematite No. 1	77/-
Hematite M/Nos.	76/6

N.W. Coast—

Hem. M/Nos. d/d Glas.	77/-
,, d/d Birm.	88/6
Malleable iron d/d Birm.	119/-

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	71/-
,, No. 3 fdry.	75/-
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/-
,, fdry. No. 3	75/-
,, fdry. No. 1	78/-

Scotland—

Foundry, No. 1, f.o.t.	76/6
,, No. 3, f.o.t.	74/-
Hem. M/Nos. d/d	77/-

Sheffield (d/d district)—

Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	90/-

Lancashire (d/d eq. Man.)—

Derby fdry. No. 3	78/-
Staffs fdry. No. 3	78/-
Northants fdry. No. 3	76/6
Cleveland fdry. No. 3	78/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	87/6
Clyde, No. 3	87/6
Monkland, No. 3	87/6
Summerlee, No. 3	87/6
Eglinton, No. 3	87/6
Gartsherrie, No. 3	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)					10	2	6
Nut and bolt iron	8	10	0	to	9	0	0
Hoops					11	0	0 and up.
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip					11	0	0 and up.
Bolts and nuts, ¾ in. × 4 in.					15	15	0 and up.
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	9	5	0	to	9	7	6
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)					9	1	0
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	10	0
Hoops (Staffs)					9	16	0
Black sheets, 24g. (4-t. lots)					11	10	0
Galv. cor. shts. (,,)					13	10	0
Galv. flat shts. (,,)					14	0	0
Galv. fencing wire, 8g. plain					15	0	0
Billets, soft					5	17	6 and up.
Billets, hard	6	17	6	to	7	2	6
Sheet bars	5	15	0	to	6	0	0
Tin bars	5	15	0	to	6	0	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	21.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	15.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	40.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.10
Plain wire	2.30
Barbed wire, galv.	2.50
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 32/6
,, furnace	20/- to 21/-
Durham foundry	21/6 to 23/-
,, furnace	19/6 to 21/-
Scotland, foundry	30/-
,, furnace	25/- to 26/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/9 to 19/-
,,	28×20	,,	37/6 to 38/-
,,	20×10	,,	27/- to 28/-
,,	18¾×14	,,	19/6
C.W.	20×14	,,	16/-
,,	28×20	,,	34/-
,,	20×10	,,	28/3
,,	18¾×14	,,	16/3

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6	0	0	to	£7	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£30	0	0	to	£31	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Mar. 5 ..	35 17 6	No	change
„ 6 ..	36 2 6	inc.	5/–
„ 9 ..	36 5 0	„	2/6
„ 10 ..	36 5 0	No	change
„ 11 ..	36 2 6	dec.	2/6

Electrolytic Copper

		£ s. d.	
Mar. 5 ..	40 5 0	inc.	2/6
„ 6 ..	40 10 0	„	5/–
„ 9 ..	40 10 0	No	change
„ 10 ..	40 7 6	dec.	2/6
„ 11 ..	40 5 0	„	2/6

Standard Tin (cash)

		£ s. d.		
Mar. 5 ..	214 5 0	inc.	75/–
„ 6 ..	213 10 0	dec.	15/–
„ 9 ..	214 0 0	inc.	10/–
„ 10 ..	214 15 0	„	15/–
„ 11 ..	214 0 0	dec.	15/–

Tin (English ingots)

		£ s. d.		
Mar. 5 ..	214 10 0	inc.	90/–
„ 6 ..	213 10 0	dec.	20/–
„ 9 ..	214 10 0	inc.	20/–
„ 10 ..	215 0 0	„	10/–
„ 11 ..	214 0 0	dec.	20/–

Spelter (ordinary)

		£ s. d.		
Mar. 5 ..	16 2 6	No	change
„ 6 ..	16 2 6	„	„
„ 9 ..	16 2 6	„	„
„ 10 ..	16 2 6	„	„
„ 11 ..	16 1 3	dec.	1/3

Spelter (Electro, 99.9 per cent.)

		£ s. d.		
Mar. 5 ..	18 5 0	No	change
„ 6 ..	18 5 0	„	„
„ 9 ..	18 5 0	„	„
„ 10 ..	18 5 0	„	„
„ 11 ..	18 5 0	„	„

Zinc Sheets (English)

		£ s. d.		
Mar. 5 ..	24 7 6	inc.	2/6
„ 6 ..	24 7 6	No	change
„ 9 ..	24 5 0	dec.	2/6
„ 10 ..	24 5 0	No	change
„ 11 ..	24 5 0	„	„

Lead (English)

		£ s. d.		
Mar. 5 ..	18 10 0	No	change
„ 6 ..	18 10 0	„	„
„ 9 ..	18 10 0	„	„
„ 10 ..	18 15 0	inc.	5/–
„ 11 ..	18 15 0	No	change

A COMPARISON OF SCRAP PRICES

Average Monthly Prices of Cast-Iron Scrap in the Principal Districts in the Years 1930–35

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
SCOTLAND (Heavy Machinery)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1930..	3 10 0	3 9 6	3 8 6	3 8 3	3 8 1	3 5 9	3 3 2	3 3 4	3 3 0	3 0 9	2 19 4	2 17 8	3 4 9
1931..	2 15 0	2 15 0	2 13 3	2 10 8	2 9 9	2 8 3	2 8 6	2 7 9	2 5 6	2 9 8	2 14 5	2 15 0	2 11 2
1932..	2 15 0	2 15 0	2 12 6	2 10 6	2 7 6	2 5 3	2 4 5	2 3 10	2 4 10	2 4 4	2 4 0	2 4 8	2 7 8
1933..	2 7 0	2 9 3	2 10 8	2 10 5	2 9 5	2 9 3	2 8 6	2 10 9	2 10 4	2 10 7	2 10 10	2 12 4	2 9 11
1934..	2 14 2	2 17 9	2 18 5	2 18 3	2 15 5	2 15 9	2 14 3	2 15 0	2 15 9	2 15 0	2 15 8	2 16 3	2 16 0
1935..	2 15 5	2 15 8	2 15 10	2 16 4	2 16 10	2 17 0	2 16 9	2 16 9	2 17 0	2 16 11	2 19 11	3 2 7	2 17 5

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
N.E. COAST (Heavy Qualities)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1930..	3 4 6	3 4 1	3 3 3	3 2 6	3 0 5	2 19 5	2 17 9	2 16 3	2 16 3	2 13 4	2 6 6	2 11 9	2 18 6
1931..	2 10 4	3 9 8	2 9 7	2 8 3	2 6 3	2 3 8	2 2 9	2 1 9	2 1 0	2 2 1	2 9 9	2 6 6	2 5 11
1932..	2 6 3	2 5 8	2 3 0	2 0 8	1 19 0	2 1 0	1 15 9	1 15 6	1 15 6	1 17 4	1 17 4	1 19 10	1 19 7
1933..	2 1 1	2 2 2	2 4 9	2 3 5	1 18 9	1 19 6	2 0 0	2 0 0	2 1 3	2 5 8	2 7 10	2 10 1	2 5 4
1934..	2 12 7	2 15 1	2 13 7	2 11 6	2 11 11	2 13 9	2 11 0	2 10 6	2 11 3	2 11 10	2 13 9	2 13 3	2 12 4
1935..	2 12 2	2 13 0	2 12 7	2 13 0	2 12 9	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 16 10	2 12 10

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
S. WALES (Heavy Cast Iron)—	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1930..	3 18 5	3 18 9	2 19 0	2 18 8	2 17 2	2 16 2	2 14 8	2 13 10	2 14 1	2 12 7	2 8 5	2 5 11	2 14 0
1931..	2 7 7	2 8 3	2 9 9	2 8 1	2 6 11	2 5 2	2 2 9	2 2 2	2 0 11	2 3 9	2 7 6	2 7 10	2 5 9
1932..	2 7 2	2 6 8	2 6 4	2 5 0	2 4 8	2 0 8	1 19 4	2 1 7	2 1 10	1 18 10	1 19 8	2 2 1	2 2 0
1933..	2 3 4	2 4 6	2 4 6	2 4 1	2 3 5	2 2 8	2 3 7	2 4 8	2 5 8	2 5 9	2 5 7	2 5 0	2 4 5
1934..	2 6 10	2 8 9	2 7 8	2 6 6	2 7 6	2 8 0	2 6 10	2 6 7	2 8 0	2 8 2	2 9 1	2 11 5	2 7 1
1935..	2 11 3	2 11 4	2 11 1	2 11 3	2 12 0	2 11 1	2 11 1	2 11 0	2 12 2	2 13 10	2 14 5	2 14 8	2 11 9

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